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U. S. DEPARTMENT OF AGRICULTURE.
DIVISION OF VEGETABLE PATHOLOGY.
BULLETIN No. 1.

6

ADDITIONAL EVIDENCE
ON THE
COMMUNICABILITY OF PEACH YELLOWS
AND
PEACH ROSETTE.

BY

ERWIN F. SMITH, Sc. D.,
SPECIAL AGENT.

PUBLISHED BY AUTHORITY OF THE SECRETARY OF AGRICULTURE.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1891.

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NOTE.

Owing to the fact that the Section of Vegetable Pathology of the Botanical Division has recently been made a separate Division by act of Congress, it has been thought best to begin a new series of publications of which this is Bulletin No. 1.

Below is given a full list of publications of the Section and Division to date. Frequent requests are received for bulletins which are out of print. Those still on hand for distribution are indicated by an asterisk (*). It will be seen that in this series Nos. 1, 3, 4, and 6 are missing. These represent bulletins of the Botanical Division.

1. Bulletin No. 2. Fungous Diseases of the Grape. 1886, pp. 136, pl. 7.
2. Bulletin No. 5. Report on the Experiments made in 1887 in the Treatment of Downy Mildew and Black Rot of the Grape. 1888, pp. 113.
3. Bulletin No. 7. Black Rot. 1888, pp. 29, pl. 1.
4. Bulletin No. 8. A Record of Some of the Work of the Division. 1889, pp. 69.
5. Bulletin No. 9. Peach Yellows. 1888, pp. 254, pl. 36.
6. Bulletin No. 10. Report on the Experiments made in 1888 in the Treatment of Downy Mildew and Black Rot of the Grape, pp. 61.
7. Bulletin No. 11.* Report on the Experiments made in 1889 in the Treatment of Fungous Diseases of Plants. 1890, pp. 119.
8. Journal of Mycology, vol. 5, Nos. 1, 2, 3, and 4. 1889, pp. 249, pl. 14.
9. Journal of Mycology, vol. 6, Nos. 1, 2,* 3,* and 4*. 1890-91, pp. 207, pl. 18.
10. Circular No. 1. Treatment of Downy Mildew and Black Rot of the Grape. 1885, pp. 3.
11. Circular No. 2. Grape Vine Mildew and Black Rot. 1885, pp. 3.
12. Circular No. 3. Treatment of Grape Rot and Mildew. 1886, pp. 2.
13. Circular No. 4. Treatment of the Potato for Blight and Rot. 1886, pp. 3.
14. Circular No. 5. Fungicides or Remedies for Plant Diseases. 1888, pp. 10.
15. Circular No. 6.* Treatment of Black Rot of the Grape. 1888, pp. 3.
16. Circular No. 7.* Grape Vine Diseases. 1889, pp. 4.
17. Circular No. 8.* Experiments in the Treatment of Pear Leaf Blight and Apple Powdery Mildew, pp. 11.
18 Circular No. 9. Root Rot of Cotton. 1889, pp. 4.
19. Farmers' Bulletin No. 4.* Fungous Diseases of the Grape and their Treatment. 1891, pp. 12.
20. Circular No. 10.* Treatment of Nursery Stock for Leaf Blight and Powdery Mildew. 1891, pp. 8.

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LETTER OF TRANSMITTAL.

SIR: I have the honor to transmit herewith a report on the investigations and experiments made the past three years by Dr. Erwin F. Smith, under the direction of this Division, with a view of obtaining evidence as to the communicability of peach yellows. There is no longer any doubt as to the contagious nature of this disease, and it now remains as a part of this line of work to determine definitely its period of incubation, methods of spreading other than by budding, and the nature of the contagium. Investigations bearing on these points, as well as exceedingly extended and laborious ones with fertilizers, are now, and have been for some time, under way.

Respectfully,

B. T. GALLOWAY,
Chief of Division.

HON. J. M. RUSK,
Secretary of Agriculture.

LETTER OF SUBMITTAL.

SIR: In accordance with your request I submit herewith a report on the evidence now at hand respecting the communicability of peach yellows.

Although some of the experiments described in the following pages have not been completed, it has been thought best to report upon them all at this time, so that peach-growers, and more especially scientific workers, may know not only just what has been done, but also what is now under way. To make the report complete the beginnings of certain experiments from the first bulletin on yellows have been repeated. A brief account of the disease, for the sake of those into whose hands the former report did not fall and also for a clearer understanding of what follows, has also been prefixed.

The histological and bacteriological part of this inquiry is as yet incomplete, and for this reason it is omitted entirely. In accordance with your instructions no report on the effect of fertilizers will be made until the results of a third year's work can be included.

A peach disease prevalent in Georgia and Kansas has also received considerable attention. This was formerly confused with yellows, but is now believed to be distinct and is so described. It is a disease of the same peculiar type as yellows and may be considered very properly in connection with the latter. The inoculations herein described demonstrate for the first time its dangerous, contagious nature, and point to prompt destruction as the best method of dealing with affected trees.

In conclusion, thanks are due to many peach-growers who have furthered my inquiries, and very especially to the men whose names are mentioned in the body of this report and whose warm interest in in the advancement of horticulture has made them willing, even at a personal sacrifice, to place their orchards and nurseries at the disposal of the Department for experimental purposes. Without this cordial coöperation much of my labor would necessarily have been fruitless.

Respectfully,

ERWIN F. SMITH,
Special Agent.

B. T. GALLOWAY,
Chief of Division.

ADDITIONAL EVIDENCE ON THE COMMUNICABILITY OF PEACH YELLOWS AND PEACH ROSETTE.

By Erwin F. Smith.

PART I.—PEACH YELLOWS.

I.—INTRODUCTORY.

(1) *Destructive nature of yellows.*—Peach yellows is a perplexing and destructive disease. On all hands it is conceded to be one of the most serious with which American fruit-growers have to contend. Formerly this disease was confined to a small district on the Atlantic coast, but during the last twenty years it has invaded distant regions hitherto free, and has entirely ruined the peach industry over very considerable areas. Within ten years the disease has taken a fresh and very strong hold upon orchards in the Delaware and Chesapeake region, the north portion of the peninsula, and has destroyed thousands and thousands of trees, rendering a great industry unprofitable or precarious. It seems to be native to the eastern United States, having, so far as we know, not been reported from California. Diligent inquiry also has thus far failed to bring to light any notice of its occurrence in Europe or other parts of the globe.

The last negative evidence is from Mr. Newton B. Pierce, of the Division of Vegetable Pathology. From May to October, 1890, he was in Mediterranean countries investigating vine diseases. Mr. Pierce traveled extensively in France, Italy, Sicily, and Algeria, and looked carefully for this disease. He examined peach trees in a great many localities, and observed the fruit in the principal markets, but failed to find any traces of yellows. Inquiries of many persons devoted to the scientific study of agriculture and horticulture also proved fruitless. They had not seen or heard of anything resembling this disease.

The distribution of the disease and the losses occasioned thereby were set forth somewhat fully in my first bulletin and do not concern us at this time. It is proper to state, however, that the losses continue in the infected districts; that the disease has appeared in new localities; and that regions now healthy are also threatened. The yellows is certainly as far south as southern Virginia and probably as far west as

Arkansas and northeastern Texas. Peach-growers are earnestly advised to stamp out the disease upon its first appearance, and are warned against the importation of trees from infected districts. These remarks apply with especial force to the Pacific coast, and in this connection it is well to remember that the apricot and almond are also subject to yellows. It would be much safer for the Californians to grow their own peach trees than to introduce any from the eastern United States. If trees are imported it should be known beyond question that they are from regions where this disease does not occur. The mere fact that the nursery stock is healthy at the date of shipment is not a sufficient guaranty that it will continue so.

(2) *Characteristics of the disease.*—The primary and peculiar symptoms of peach yellows are only two: (1) The red spotting and abnormally early maturity of the fruit; and (2) the premature germination of ordinary winter buds, or of obscure buds buried in the bark of the trunk and limbs or formed in the cambium. All other symptoms result from these, or are only the common indications of disease and decay in plants.

Plate I represents two peaches, natural size, one healthy and the other diseased. They are of one variety and were gathered the same day. They were picked from neighboring trees, but might have come from the same tree, since in the first stages of yellows both sorts are usually found upon the same tree. The unspotted peach (Fig. 1) was hard, green, and normal in all respects. It would not have ripened under two weeks. When ripe its skin would have been creamy white with a blush on one cheek, composed of very minute and nearly uniform crimson punctations. Its flesh would have been melting and juicy, slightly acid, aromatic, and delicious. The color of the flesh would have been uniformly white, except for a narrow zone of crimson immediately surrounding the stone. The diseased peach (Fig. 2) was fully ripe. Its size was normal; its color, abnormal. The skin was beautifully mottled and blotched with crimson, giving an appearance quite unlike that of healthy fruit. Many of these spots were large enough and sufficiently unlike the rest of the skin to admit of being easily photographed. The flesh was also copiously streaked and spotted with crimson. On tangential section these brightly colored portions were usually oval or roundish; on radial section they appeared more often in the form of streaks or elongated spots. There was also more than the usual amount of color around the stone. The flavor of the peach was inferior. This diseased peach was only one out of thousands occurring that year in the infected districts. High-colored, premature fruits are one of the conspicuous symptoms of the disease, and are easily distinguishable even from a car window. In July, 1891, I saw hundreds of bushels of this worthless fruit in upper Maryland and Delaware, and the entire loss thereby in 1891 certainly exceeded half a million dollars.

The amount of color appears to depend somewhat upon variety. Sometimes there is comparatively little crimson spotting, and again, it is a very marked feature, the skin being almost purple and the flesh of the deepest crimson, even in pure white varieties. In an experience covering four years and including a great many thousand trees diseased by yellows, I have never known but one in which there was entire absence of red spotting in the fruit. This tree bore premature, insipid peaches and the characteristic shoots. The time of ripening also varies within wide limits. I have known such peaches to ripen forty days in advance of the proper time, and also to ripen with the healthy fruit or only a few days in advance. Generally they ripen two or three weeks in advance and are gone when the healthy fruit matures. In size the prematured fruit is usually normal the first season, and sometimes even noticeably large and showy. If any is produced the second year it is commonly small and inferior. The taste varies as much as the color, running from tolerably good to mawkish or bitter. Such fruits are generally insipid, even when of good size and color, and their sale not only defrauds the consumer but also reacts upon the grower, seriously impairing the subsequent demand for healthy fruit.

In many cases the red-spotted, prematurely-ripened fruits are the first indications of disease, or at least the first symptoms striking enough to attract general attention. They are very often borne exclusively upon one or two limbs of otherwise healthy-looking trees. These limbs are not different in appearance from the rest of the tree. They bear vigorous shoots and full-grown, smooth, dark-green foliage; often, also, green half-grown fruits, which afterwards ripen in a normal manner. There is no indication of disease except in the fruit, which, in color and size, contrasts strikingly with the fine green foliage and the normal immature fruit. Occasionally, in places, the foliage already begins to look yellowish green, while weak, pale sprouts begin to push through the bark. Sometimes branches bearing good foliage are covered from base to tip with these feeble shoots. They grow vertically through the bark on the upper surface. Later, in summer or autumn, or the following spring, such branches begin to show marked indications of disease. The spring foliage is yellowish or reddish green, dwarfed, rolled, and curled; and the shoot-axes are stunted. Commonly, especially in moist seasons, many feeble branched sprouts are developed on the trunk and the base of the main limbs. Again, stem and limb shoots will grow normally and very vigorously for several feet and then all at once branch repeatedly near the extremity in a very feeble and peculiar way. Many of these growths are due to the excessive and abnormal development of obscure buds hidden in the deeper layers of the bark or developed from the cambium. Why they should germinate in such numbers, and often in midsummer or autumn when the tree has passed its period of active growth, remains to be explained. The appearance suggests a profound disturbance of the distributive metabolism of the plant followed by an equally profound distubance of the function of assimilation. The branched character of many of the growths results from the premature and abnormal development of ordinary winter buds. These begin to grow as soon as they are formed in the leaf axils, and the feeble shoots to which they give rise develop buds which also germinate the same season, and so on (plates V and VI). The winter buds upon healthy-looking terminal branches and stem and limb shoots may also unfold prematurely into diseased growths. This may take place at any time from early spring to late autumn. It is very common in September, October, and November, and is one of the striking characteristics of this disease (plate II, from a photograph made at Amherst, Massachusetts, December 4; see also plates III and IV, made from photographs taken in Maryland in the autumn of 1890). Plate II represents a shoot taken from the trunk near the earth. Plate III represents one healthy shoot and three diseased shoots taken from the base of main limbs. The spring foliage remains on the healthy shoot (Fig. 2) and its winter buds are dormant. On the contrary, nearly all of the spring foliage has fallen from the diseased shoots (Fig. 1), and many of the winter buds, terminal and axillary, have germinated. Plates IV and VI represent the same appearances in terminal branches. The prematurity extends also to the blossoms, which generally come out earlier than on healthy trees, and appear sometimes even in autumn (plate IV, made from a photograph taken October 15, 1890). My attention was first drawn to this symptom in the spring of 1890, but extensive observations were then impossible. In the autumn of 1890, and again in the spring of 1891, about 6,000 trees were examined with special reference to the effect of yellows upon the blossoms. All of these trees are in Maryland and Delaware, and all were healthy in the autumn of 1890. About 500 of them were found diseased in whole or in part in the spring of 1891, having developed yellows between fall and spring. The most characteristic symptom was the general pushing of leaf buds one to two weeks in advance of the proper time. This was peculiarly striking by contrast whenever the trees developed symptoms on one or two limbs only. On many of these trees some of the blossoms also came out very early, and were destroyed by frosts, but in general, the disease could be detected in these trees before the blossoms opened.

In this climate under normal conditions winter buds of the peach do not germinate until after a considerable period of rest. They never unfold in the autumn, and it is difficult to induce them to do so even in winter. This period of rest may be shortened somewhat by mild winters and early springs, or by artificial means, *e. g.*, June budding, but it is not abrogated in nature, so far as I know, except under the influence of this peculiar disease, and the one described in Part II.

When the winter buds become affected in spring, the growths to which they give rise are occasionally more extensive but are somewhat variable, their appearance depending, of course, to a great extent, upon the length of the internodes and the amount of branching. Different forms of these terminal spring and summer growths are shown in plates v and vi. Plate v is from a Michigan tree, and is very unusually tufted. Plate vi, No. 1, is the ordinary Delaware form; while No. 2 of the same plate is an appearance common in late autumn. In Delaware and Maryland these last were more than usually abundant in the tops of vigorous trees in the summer and autumn of 1890.

So much concerning the characteristics of the disease. Now, in conclusion, some words upon its progress.

Gradually or simultaneously, as the case may be, all of the limbs develop the same symptoms. Consequently, the tree falls into a decline and finally dies. Trees once attacked rarely, if ever, recover. This statement is still in dispute, but I feel quite sure. Hundreds of yellowed and decaying orchards on the upper part of the Chesapeake and Delaware peninsula bear witness every day to the truth of this assertion. In a very few instances I have had trees pointed out to me as once diseased and now recovered, but no such cases have ever come under my own observation. Always such trees have shown symptoms of disease later on, or else there was some uncertainty connected with the original diagnosis of the case (p. 30).

The duration of the disease varies greatly. If the symptoms progress slowly from limb to limb, the tree may live a long time. If the whole tree is speedily involved, decay and death are correspondingly rapid. I have known trees to die at the end of the first season, but such is not usually the case. In Maryland and Delaware, as well as in regions farther north, the affected trees generally live from two to five years, and possibly longer in some cases. Incidentally I am keeping watch of several hundred trees to determine this point more accurately. The trees are worthless from the start and should be removed as soon as the disease appears. If allowed to remain, complete death occurs, very frequently, the third or fourth year, the last feeble sign of vitality being a few yellowish tufts on the trunk or some of the limbs (plate vii*a*). The tree shown in plate vii*b* was attacked in the spring of 1887, when it was 5 years old, *i. e.*, set 5 years. At that time the tree was remarkably vigorous and handsome. It died in the summer of 1890, *i. e.*, about 3½ years from the time it first developed symptoms, but its foliage was yellowish the second year, and vegetation during the last year of its life was very scanty and feeble, being confined principally to branching sprouts on the bases of the larger limbs.

Generally speaking, the longer the disease has prevailed unmolested in any locality the greater is the number of cases annually, and the less is the probability of getting trees up to bearing age before they are attacked. This peculiar and interesting fact has been observed repeatedly in Connecticut, New York, New Jersey, Maryland, Delaware, and Michigan.

II.—INOCULATIONS.

Experiment 1.—The trees selected for this series of inoculations were grown from Smock seed, procured in Kent County, Maryland. They formed part of a large nursery owned by Norris Barnard, Still Pond, Maryland. When first seen the seedlings were about 5 months old, and were being worked for commercial purposes. They numbered more than 100,000, and all presented a very healthy, thrifty appearance. The trees devoted to the experiment were in one corner, and not different in appearance from the rest.

The buds for inoculation were cut in an orchard on the Bay farm of James S. Harris, Still Pond, Maryland. They came from *diseased shoots* on 15 or 20 vigorous, 4-year-old trees. These trees had shown no symptoms of disease until that summer, when they bore the red-spotted, prematurely ripened fruit as well as the characteristic shoots.

The buds were cut August 12, 1887, and inserted the same day. The manner of insertion was like that ordinarily practiced in reproduction by budding, *i. e.*, the bud, with a portion of the surrounding bark and often some of the underlying wood, was inserted under the bark of the seedling about 6 inches from the ground, by means of a T-shaped slit. The insert was then bound into place securely by strings, which were cut or loosened at the expiration of ten days. According to their size the trees received one or two buds, none more than two.

In most instances the wood and bark which were inserted healed on quickly and retained their vitality over winter, but there was no growth from the buds that autumn, nor any symptoms of disease in the stocks. The seedling tops were removed in the spring.

One year from budding these trees were reëxamined. Three-quarters of the inserted buds had failed to push. Of the rest some had grown into diseased shoots; others (a few) had grown into shoots which did not yet show the characteristic symptoms of yellows. The effect on the stocks was marked. About 34 per cent of the whole number (202) had become diseased beyond question, while only 23 per cent were entirely healthy. Some of the trees had died during the summer, evidently from the effects of the disease. A few yet living were badly affected, but most of them showed only slight symptoms. Nevertheless, here were the feeble shoots and the winter buds germinating 6 months in advance of the proper time.

The evidence seemed to be overwhelming and complete, for while the experiment was performed in a region were the disease occurs it was on a large scale, and moreover the remainder of this nursery and other nurseries in the same region, subject so far as known to the same influences, were examined in vain for anything which would correspond. The 542 trees in adjoining rows, which were examined critically for comparison, showed no traces of the disease, although all other conditions appeared to be identical. The fact that peach yellows in that locality was comparatively rare in trees under 3 years of age is also opposed to the view that the proximity of diseased orchards had anything to do with this special case. With a full knowledge of the facts the conclusion was irresistible that the infection came only from the inserted buds.

An examination made in November, *i. e.*, 3 months later, showed plainly that the disease was progressing—more trees were dead and fewer were healthy. At that date the number of stocks clearly affected amounted to 40 per cent. The control trees were still free from the disease, although they stood close upon both sides in parallel rows. Plate VIII, made from photographs, shows the condition of 3 of these inoculated trees November 3, 1888.

Ten of the inoculated and diseased trees were removed that autumn and set in Washington on the grounds of the Department of Agriculture. The remainder were left over winter in the nursery rows. In the spring of 1889 the latter were carefully removed and set out on the farm of Dr. W. S. Maxwell, some miles distant. None made any growth worth mentioning and all died within a year—some from the shock of transplanting and the rest with plain symptoms of yellows.

The ten trees set on the Department grounds made considerable growth in 1889, and developed into very characteristic specimens of yellows. The germination of the winter buds 6 or 8 months in advance of the proper time occurred freely on many shoots arising from the stock and fully set at rest all lingering doubts respecting the nature of the disease. The foliage was yellowish or reddish, and the total growth as compared with neighboring healthy trees was also very meager and stunted (plate IX, from a photograph made October 21, 1889, wherein the trees are contrasted with two healthy seedlings—each 1 year younger). Plate X, from a part of the same row, brings out certain details more distinctly. These trees were again photographed, November 21, 1890, at which time the unbudded seedlings were much larger and still healthy, while the inoculated trees were dead or nearly dead (plates XI and XII). Between this date and the time when the trees were set they were examined repeatedly and shown to various persons. During all this period they had unmistakable symptoms of yellows and became gradually more and more feeble. The moving of the trees into different and fertile soil did no good. The five unbudded seedling trees standing in the same row are more than 100 times as large, although one year younger. There was no shock from transplanting, and the difference in size must be ascribed to the stunting effect of the disease. In passing, it is interesting to note that the 5 healthly seedlings are those noted in my first Report,* p. 145, as having grown from the pits of premature peaches. These trees have continued healthly and now bear a heavy crop of green fruit (July, 1891).

*** Peach Yellows: A preliminary report. U. S. Department of Agriculture, 1888.**

Of the entire 202 trees inoculated August 12, 1887, only 3 are now living, and each of these is badly diseased and likely to die within 6 months. Of this experiment it may be said that all doubts concerning the nature of the disease were long since set at rest. It has corresponded exactly in manner of development and in results to the disease in the trees from which the buds came. Exception must, of course, be noted that none of these trees have ever borne fruit.*

The virulent nature of the disease is shown by the fact that only one or two buds, *i. e.*, 1–2 square centimetres of diseased surface, were inserted into each tree. Its slow progress through the tissues is inferred from the fact that no symptoms were visible until after 3 months and probably none until the following May or June—8 to 9 months after the date of inoculation. It should also be noted that the inserted buds produced the same effect, although cut from many different trees.

Experiment 2.—The trees selected for this series of inoculations were much like those used in No. 1. They were grown from Tennessee seed and formed part of a large nursery owned by Thomas J. Shallcross, Locust Grove, Maryland. The seedlings numbered about 100,000, and were very thrifty. I first saw them at budding time, when they were about 5 months old. The trees devoted to this experiment were two outer rows, not different in appearance from the rest.

The buds for inoculation were cut from an orchard on the same farm. They came from *healthy-looking shoots* on a vigorous 6-year-old tree. This tree had shown no symptoms of disease until that summer, when some of its limbs bore premature fruit and the characteristic shoots.

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* So far as I know, the only *well-authenticated* case in which buds taken from a diseased tree and inserted into a healthy stock have lived long enough and developed vigorously enough to bear peaches, is one communicated by Prof. E. S. Goff, horticulturist of the State Experiment Station, Madison, Wisconsin. This experiment was begun on the grounds of the Experiment Station at Geneva, New York, in 1886. Professor Goff's statement from memory is as follows:

"The tree budded was a very vigorous seedling of bearing size. In the latter part of the summer in 1886, I budded several of the branches with buds of two (or three?) varieties of the peach, sent me by a young man of western New York whose orchard was badly infested with yellows and who was deeply interested in the subject. He assured me at the time that the buds came from diseased trees.

"More than one-half the buds failed, but several survived and made a good growth the following season, without exhibiting any abnormal appearance. The next season (1888) the branches from the buds bore a good crop of fruit, and the peaches early began to manifest a peculiar appearance, which I recognized from description as the yellows. The ground of the fruit became a golden-yellow color, sprinkled and blotched on the sunny side with very bright or sometimes with deep red. I am not personally familiar with the yellows, having seen but a few trees affected with it, but I came to the conclusion that the branches from the buds inserted into this tree were attacked with the disease. I came away from Geneva in the spring of 1889, and in the fall of that year, anxious to know what further symptoms this tree had manifested, if any, I wrote to Mr. Churchill, who then had charge of the fruit trees, and was informed by him that the tree had died."

Dr. Collier, the present director of the Geneva Station, says that the tree was in an exposed situation and died from an accidental injury.

One limb of the tree was badly diseased only a short distance from where the shoots were cut.

The buds were cut August 3, 1887, and inserted the same day. One bud only was put into each tree. The manner of inoculation was substantially like that already described. Subsequent examination showed that a union between bud and stock had taken place in every instance, or nearly every one, the budder having been very expert. No buds pushed and no symptoms of disease developed that autumn.

In the spring of 1888, while the buds were yet dormant, these trees were removed to Hubbardston, Michigan, and set 10 by 10 feet apart, principally upon a moderately fertile, sandy loam, which had been used for a garden. This location was selected as, on the whole, the best that could be had at that time. The soil has been cleared of forest and brought under cultivation since 1850. There were and are no known cases of yellows within 40 miles, and the nearest commercial orchards are 20 miles away, and not extensive. By long residence I am familiar with the whole country, and believe that the only peach trees in that township or the adjoining ones are such as have been planted very sparingly in gardens or around houses. To most farms and gardens this tree is an entire stranger. The principal objection to the location, and a serious one, was the danger from low winter temperatures and sudden fluctuations, which in the past had frequently killed peach trees to the ground, and consequently had long since very effectually discouraged planting. However, the risk was taken, and, as good fortune would have it, the winters of 1889 and 1890 were so mild that the trees did not suffer in the least.

Altogether 336 trees were set, and upon my father's place, that I might have the land more fully under control. Two hundred and ten were the inoculated trees already mentioned and 126 were unbudded seedlings from the same nursery to be used in making comparisons.

These trees were set out April 24, under personal direction, and were examined carefully, one by one, as late as June 26 of that year. At that date there was no difference in the appearance of the two lots. Six of each were dead, apparently from the shock of transplanting. The remainder of the unbudded trees were perfectly healthy; and the remainder of the inoculated ones appeared to be so, with the exception of one tree which began to look suspicious. In 60 per cent of the inoculated trees the bud had failed to push, although the bark inserted with it was yet alive in most instances.

In 96 per cent of the seedlings the top was purposely allowed to remain at the time of transplanting, only enough being removed to balance the slight loss of roots. The others were cut back to the inserted bud. The trees suffered no injury in transit, were provided with excellent roots, and, with the exception of 87 set in new ground on upturned and tough sod, grew vigorously from the start and promised well.

In autumn, on several occasions, my father reported that some of the inoculated trees had begun to look yellow and sickly. However, I did not see them until July 1, 1889, *i. e.*, one year from the previous examination and twenty-three months from the insertion of the buds. The change was then so great that I could scarcely credit my eyes. With one exception, the unbudded trees continued healthy and had made a good growth. On the other hand a very considerable number of the inoculated trees were already dead, and most of the remainder were in all stages of decline, dwarfed, yellow, and sickly. Evidently some sort of virus was communicated by the inoculated diseased bud to the previously healthy seedling, and this was probably transmitted to all parts of the tree. At least, symptoms were visible to the very extremities of the branches, 3 to 4 feet from the point of inoculation. A few trees only had made a tolerable growth and seemed to be resisting the evil influence.

As in Experiment 1, here were the feeble, branched growths and the winter buds germinating months in advance of the proper time. Again there could be no question as to the nature of the disease. Some representative photographs (plates XIII–XVII) made July 1, 1889, show, as well as can be done in black and white, the strikingly different appearance of these two lots of trees. The exact conditions in August were as follows:

TABLE I.—*Result of inoculations two years from the time the buds were inserted as shown by comparison of budded and unbudded trees.*

126 unbudded trees.				210 budded trees.			
Healthy.	Doubtful.	Diseased.	Dead.	Healthy.	Doubtful.	Diseased.	Dead.
117	1	0	8	3	16	103	88

From that day to this the contrast has become greater and greater as the condition of the inoculated trees has gone on from bad to worse.

The orchard was reëxamined July 29–31, 1890, and another series of photographs procured (plates XVIII–XXIV). The condition of the inoculated trees was found to be much worse than last year. All which were doubtful or seemed to be healthy in 1889 had become diseased, and many more had died with the characteristic symptoms of the yellows. Only two of the inoculated trees made any noteworthy growth in 1890, and the best one of these two is shown in plate XVIII, fig. 1. Of the entire 219* trees which received diseased buds August 3, 1887, only 15 were living at the expiration of the third year. Nearly all of those which died were more or less stunted and showed symptoms of yellows either in the form of branching summer growths or of winter buds which germinated in autumn.

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*Nine were rejected at time of planting on account of injuries received in digging. The number 198 given in my *Preliminary Report* is a typographical error.

Up to date only one case of yellows has developed in the unbudded trees, the tree noted as suspicious in 1889.

A number of the unbudded trees at one end of the orchard died in the spring of 1890 from some unknown cause, not yellows. They dried up suddenly, much as if they had been injured by plowing or by moles. The roots, however, seemed intact and the origin of the trouble was not to be learned in July. It is sufficient that it was not yellows or anything suggestive of that disease. Four of the trees set on sod ground also dried up during the summer. All the rest of these trees (86) made an excellent growth in 1890 and were thrifty and beautiful to look upon (plates XXIII and XXIV).* The photographs from the unbudded trees represent average specimens, while those from the inoculated trees include the best, and, in fact, almost everything.

For several reasons this experiment is more interesting than No. 1, although the results are identical. First, the inserted buds were taken from shoots that appeared to be healthy; second, the disease developed more slowly than in Experiment 1, owing probably to the different character of the buds; third, a smaller amount of infective material was used; fourth, the inception and progress of the disease occurred in a locality entirely free from yellows. This experiment confirms No. 1. In addition, it proves that yellows may be communicated by parts of a tree which seem to be healthy and renders it probable that the disease is incubating in all parts of a tree when it appears in any part. In passing, it may be said that the results of the excision experiments described in Part III point to the same conclusion. It is also noteworthy that each of these trees was infected by a single bud, and that all of these buds were cut from a single tree. The inference is very strong that this one tree contained infective material sufficient to destroy entire orchards if properly introduced into the trees. Both experiments go to show that the germ or virus of the disease must be quite uniformly distributed through the affected parts.

Experiments 3 *and* 4 (the R. G. Nicholson trees and the D. P. Barnard trees) are incomplete, owing to the temporary discontinuance of this investigation in the spring of 1888.

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*These trees were re-examined August 12, 1891, with the following results:

Average height of the north two rows (37 trees), 9.9 feet; average circumference of trunk, 8 inches. Average height of the south three rows (49 trees), 8.1 feet; average circumference of trunk, 5.7 inches. Twelve of the trees have mildewed badly this year, one has yellows, and several others are small. Otherwise all are healthy and growing vigorously. The difference in amount of growth is referable to the unlike methods of treatment. They have been cultivated with crops as follows:

Plot.	1888.	1889.	1890.	1891.
North two rows....	Corn and cucumbers..	Corn...............	Strawberries	Strawberries.
South three rows ..	Corn.....................	Wheat.............	Clover	Corn.

The growth of a crop of wheat in 1889 and the absence of cultivation the following year, when the trees were in clover sod, checked the growth of the south three rows nearly one-third. Of the inoculated trees only six remain, and they are like the three left from Experiment 1.

At the time of removal Mr. Barnard reserved ten trees from experiment 4, and set them with others of the same age in an orchard on his farm. According to his statement, January 10, 1889, they made a good growth in 1888 and were as healthy as any trees. September 20, 1890, Mr. Barnard reported that the trees were still healthy, but they were not personally inspected until January 26, 1891.

At that date the following conditions prevailed: One tree was gone; one tree had made no growth worth mentioning and was dead with symptoms of yellows; three were much smaller than should be and were suffering from yellows or at least presented what seemed to me satisfactory symptoms; one was doubtful; and four were nice trees. The latter had made a reasonable growth and appeared to be free from disease. Plate XXV shows the best one of the healthy trees. These trees were budded in a locality where yellows is very prevalent and have remained there ever since, *i. e.*, over 3½ years. Therefore, it can not be asserted unqualifiedly that the diseased trees resulted from the insertion of diseased buds, since the possibility of subsequent infection is not excluded. The possibility, however, is not great, because the trees were badly dwarfed, as if they had been diseased from the start The trees which still appear to be healthy are, therefore, the only really interesting ones. Their behavior during the next year or two will be a matter of considerable interest, as throwing additional light on the question whether the whole tree is diseased when symptoms appear in any part of it.

For this experiment the buds were selected with great care from *terminal branches* upon the healthy-looking side of a diseased seedling tree which was about 4 years old. If any portion of the tree was free from the disease these branches should have been. The buds were cut and inserted September 7, 1887. The tree from which they were taken manifested symptoms of yellows in all parts in the spring of 1888, and died that summer.

One failure of another kind remains to be recorded. A large and vigorous seedling tree in the yard of Prof. Cleveland Abbe, in Washington, was inoculated in a dozen terminal branches with buds taken from one of the 10 trees set on the Department grounds and described under Experiment 1. The buds were cut August 15, 1889, and inserted the same day. The growth of the tree from which the buds came had been stronger and healthier looking than that of the others, but fully one-half of the winter buds were then germinating and the inserted buds were of this character.

This tree has remained healthy, but no stress should be laid upon the fact because owing to the use of a dull knife or to the fact that the shoot-axes had already pushed, all of the buds dried up in a few days and entirely failed to unite with the branches. So far as relates to the propagation of yellows it must be classed with pruning and other experiments of simple contact and I have not yet obtained any indisputable evidence that the disease can be spread in this way, although it seems very probable. Several extensive experiments of this kind are now in progress. In experiments 1 and 2, in all or almost all of the inoculations there was a distinct union between the bud and the stock, *i. e.*, between the diseased and healthy tissues, some months prior to the first appearance of symptoms in the stocks.

Experiment 5.—In order to be absolutely certain as to the healthy character and sound constitution of the seedlings, stones were procured in quantity from three localities free from yellows. These were planted November 8, 1889, upon well drained and fertile soil in the grounds at the Department of Agriculture. Row No. 1 were Tennessee pits. "These pits were bought of Johnson & Stokes, Philadelphia, and came from London, Tennessee." I procured them from Charles Wright, Seaford, Delaware. Row No. 2 came from Sussex County, Delaware, and were also procured from Mr. Wright, who had purchased them for his own use. Concerning them he wrote: "The Delaware pits were collected by myself of William P. Brown, of Seaford, and were saved from old seedling trees in his orchard near town." Row No. 3 came from Caroline County, Maryland. They were collected by J. W. Kerr, of Denton, for his own use.

The seedlings came up satisfactorily and made a good growth in the season of 1890. About 100 of each row were inoculated and the rest were reserved for future experiments.

The buds for inoculation were selected with the greatest care from 17 diseased trees in the older orchard of James W. Green, Magnolia, Delaware (No. 14 of first report). I did not have an orchard map when the buds were cut, but, judging from the appearance of the trees, all were cases of 1889. Each one was plainly diseased by yellows, but none were wholly diseased, *i. e.*, none appeared to be so. One-third to one-half of each tree was more or less yellow and bore the diseased shoots, but the other side was green and thrifty and although examined very minutely gave no indication of disease. Two shoots were taken from each tree (different limbs). These were 2 to 3 feet long, robust, well matured for the time of year, and to all appearances perfectly healthy. Each shoot came from the healthy-looking side of the tree, and all bore smooth, green, and vigorous leaves, 6 to 9 inches long. Better *looking* buds were never used. These shoots grew out at much greater distances from diseased parts than those used for Experiment 2. They were cut July 18, 1890, immediately stripped of foliage, and wrapped in damp cloths. Row 1, was budded July 19; row 2, July 21; and row 3, July 22. All of the buds were used except some on the base of the shoots which proved too large for the stocks. Two buds were put into each seedling, but owing to dry weather and unskillful manipulation, many of them failed to unite with the stock. Others healed on satisfactorily but made no growth. Still others made a growth of 1 to 10 inches, although the upper portion of the stocks was purposely left uncut in order to prevent this.

The stocks were healthy (December 13, 1890), and it was only the few buds which had already developed into shoots that I desired to notice here. None of these appeared to be perfectly healthy, and some of them had developed very characteristic symptoms of yellows. Plate XXVI, from photographs, represents two good examples. One is from row 1, the other is from row 3. In both a majority of the winter buds germinated in autumn. Since then there have been new developments. At this date (July 16, 1891), 28 stocks show symptoms of yellows, and the foliage on five or six vigorous shoots, which have grown from inserted buds, begins to take on a peculiar yellow tint very suggestive of this disease. There are cases in each of the rows, but most at present in the S. row.

This experiment is, in part, a repetition of No. 2. Whether these trees (the stocks) will all perish in the same way remains to be seen. Another point important to be settled is whether *any* of the inserted buds will develop into healthy trees. The seedlings will be transplanted at an early date to a locality entirely free from yellows and kept under observation until this can be determined.

III.—EXCISIONS.

Symptoms of peach yellows, as already noted, frequently appear at first on one branch only, or on one side of a tree, while the rest remains for several or many months, to all appearances, perfectly normal. The symptoms of the disease are progressive from part to part until the whole tree is involved, and this has favored the idea that the disease is local at first and only constitutional or universal after the lapse of considerable time. Generally, in bearing years the earliest plain symptoms are found in the fruit, and this fact has led to a strong popular belief that the disease is communicated from tree to tree by pollen, through the instrumentality of bees or otherwise. There is, however, absolutely no foundation in observation for any such belief. The following experiments were undertaken in the hope of determining whether the disease is local or constitutional when the first symptoms appear. Assuming that the cause of the disease is a contagium which has gained an entrance into the tree through such blossoms as develop into prematurely ripened fruit, then it follows that the disease is first of a local nature, as the appearances indicate; and it would seem that it might be removed, in some cases at least, if the excisions were very prompt and rigorous. Anyway, this was the theory on which I proceeded.

The experiments are as follows:

A.—*Orchard of William Brothers, Dover, Delaware.*—Trees set 3½ years; both of them cases of 1887; selected out of 27 as being most suitable for this experiment. The limbs which bore affected branches were cut away close to the body of the tree, and the stumps were painted.

(1) September 16, 1887. Variety, Beers' Smock. This tree seemed to be healthy, except parts of one large limb. This limb showed slight beginnings of diseased sprouts, and bore one peach, which was ripe, red-spotted on the skin and red spotted and streaked in the flesh. The limb was removed.

RESULT.—August 16, 1888. The tree is full of peaches, and three-fourths of them are now ripe and red-spotted. The proper time of ripening of this variety in this locality is about the middle of September. Only two small limbs bear green, healthy fruit. The foliage of the affected limbs is yellowish, and they bear a few small diseased shoots.

(2) September 16, 1887. Variety not recorded. This tree bore no fruit, but diseased sprouts had developed on one limb, and to a greater extent than on No. 1. This limb was cut away. The rest of the tree seemed to be healthy.

RESULT.—August 16, 1888. The tree is badly diseased. It now bears premature fruit on all parts. Also on all of the main limbs there are many diseased shoots, and some of them are large.

All of the diseased trees, except these two, were removed in 1887.

B.—*Orchard of James W. Green, Magnolia, Delaware.*—Trees set 5½ years; all cases of 1887; selected out of several hundred as being freest from symptoms of yellows. In all of these trees the disease appeared to be localized on one or more of the several main limbs. In fact, I was at great pains to select trees which showed the premature peaches and feeble shoots only upon a few limbs. Many otherwise promising trees were rejected because of slight symptoms upon the base of the main limbs. In several cases there were yet no diseased sprouts. In none were there very many. In some of the trees healthy shoots of that summer had grown out between the diseased parts and the point of amputation. The limbs were sawed off smoothly and the stumps were painted. Whenever a small diseased branch joined a larger healthy limb I severed both, cutting below next to the body of the tree in order to be more certain of success. In most cases, from one-third to one-half of the tree was removed. All that was left, and much of what was cut away, appeared to be perfectly healthy. In some trees the symptoms of disease were more pronounced than in others, but the final results were the same.

(1) September 15, 1887. Variety, Beers' Smock. Two main limbs were removed; five of the same size were left.

RESULT.—August 17, 1888. The tree now bears premature fruit on every main limb. It also bears diseased shoots. Some of the smaller branches bear a few sound peaches.

(2) September 15, 1887. Variety, Beers' Smock. Three limbs were removed; three were left.

RESULT.—August 17, 1888. The tree bears many peaches, most of which are premature. Upon two of the three main limbs, some branches only still bear green, healthy peaches. The trunk and limbs also bear diseased shoots.

(3) September 15, 1887. Variety, Beers' Smock. One small limb, 1½ inches in diameter at the base, was removed; four large limbs with many branches were left.

RESULT.—August 17, 1888. The tree is now badly diseased in every limb, and bears almost nothing but premature fruit, *i. e.*, there are not over 40 green peaches on the entire tree. Diseased shoots have also grown from every limb and from the trunk near the earth.

(4) September 15, 1887. Variety, Beers' Smock. A smaller tree than No. 3. One limb was removed, two were left.

RESULT.—August 17, 1888. One of the two main limbs bears green, healthy peaches; the other bears mixed fruit. That on two branches is premature; that on three others is healthy. There are no diseased shoots.

(5) September 15, 1887. Variety, Beers' Smock. A large, fine tree. One limb was removed, four limbs were left.

RESULT.—August 17, 1888. The tree is now full of fruit and at least one-half of it is premature. The diseased peaches are not confined to any special part but are borne on all of the main limbs. There are also characteristic, feeble shoots on the trunk.

(6) September 15, 1887. Variety, Beers' Smock. A large tree. One limb was removed, four were left.

Result.—August 17, 1888. Two of the four limbs bear green, healthy peaches; and two bear premature ones, far out toward the ends of the branches. Diseased shoots have also grown from the base of these two limbs and from the trunk below the excised limb. There are a few green peaches on the prematured limbs.

(7) September 15, 1887. Variety, Wilkins' Cling. Two limbs were removed, three were left.

Result.—August 17, 1888. One limb is sound, *i. e.*, no symptoms have developed. The other two bear mixed fruit; on some branches it is premature and now fully ripe, on others it is healthy and still green. Both limbs bear branched and very characteristic yellows shoots.

(8) September 15, 1887. Variety, Wilkins' Cling. One branch was removed from a large limb. The remainder of this limb and three other limbs were left.

Result.—August 17, 1888. One limb bears green, healthy peaches; the others bear prematurely ripe fruit and branched and unbranched yellows shoots. But some branches bear sound peaches. The limb from which the branch was removed is not worse affected than another on the opposite side of the tree.

(9) September 15, 1887. Variety, Wilkins' Cling. One small limb was removed; three larger ones were left.

Result.—August 17, 1888. Most of the peaches on this tree are green and healthy, but branches upon two of the three limbs bear ripe red-spotted peaches and the diseased shoots.

(10) September 15, 1887. Variety, Beers' Smock. One limb was removed; three limbs were left.

Result.—August 17, 1888. There are many premature peaches on all parts of the tree, but some of the branches still bear green ones. There are no sickly shoots.

(11) September 17, 1887. Variety, Crawford's Late. One limb was removed; three were left.

Result.—August 17, 1888. Most of this tree is healthy, *i. e.*, appears to be. Two branches of one limb only bear premature, ripe fruit, and small feeble shoots. A large branched shoot, very typical of yellows, has also grown from the body below the excised limb.

(12) September 17, 1887. Variety, Crawford's Late. Two limbs were removed; three were left.

Result.—August 17, 1888. There are premature peaches and characteristic yellows shoots on every main limb. Some of the branches on these limbs also bear green, healthy fruit.

(13) September 17, 1887. Variety, Old Mixon. One limb was removed; three were left.

Result.—August 17, 1888. Most of the tree bears green, healthy peaches. One limb, however, bears nothing but ripe prematures. A small branch on another limb also bears this kind of fruit. The sickly shoots have developed on both and on the trunk below the excised limb.

(14) September 17, 1887. Variety, Old Mixon. Two limbs were removed; three were left.

Result.—August 17, 1888. All of the main limbs bear premature peaches and diseased shoots. There are also two much-branched, yellows shoots on the trunk—one below the excised limbs and one on the opposite side. The tree still bears some green, healthy peaches.

(15) September 17, 1887. Variety, Stump the World. One limb was removed; three were left.

Result.—August 17, 1888. One limb bears green, healthy peaches. The other two bear mixed fruit, *i. e.*, premature, fully ripe peaches on some branches and immature normal ones on other branches. There are no diseased shoots. One small branch on this tree bears premature peaches upon three twigs, and green peaches upon two others. One of the latter is 3 inches and the other is 14 inches below the lowest twig bearing the prematures. The foliage and bark on this branch appear to be perfectly normal, and I can see no difference between the twigs bearing sound peaches and those bearing diseased ones.

(16) September 17, 1887. Variety, Stump the World. One limb was removed; three were left.

RESULT.—August 17, 1888. This tree bears a great quantity of fruit and only a very a little of it is premature. One diseased shoot has grown from under the excised limb, and there are several noticeable ones at the junction of the stem and roots. Otherwise the foilage is normal and the tree appears to be healthy.

(17) September 17, 1887. Variety, Stump the World. One limb was removed; four were left.

RESULT.—August 17, 1888. There are premature peaches and numerous diseased shoots upon every limb. Some of the shoots are much branched.

(18) September 17, 1887. Variety, Stump the World. One limb was removed; three were left.

RESULT.—August 17, 1888. This tree bears only a few peaches. On two limbs there are a few prematures, and one shoot which has grown from the trunk beneath the excised limb does not look perfectly healthy. The foliage of the tree is normal, and as in No. 16 the symptoms are slight.

(19) September 17, 1887. Variety, Stump the World. One limb was removed; three were left.

RESULT.—August 17. 1888. There are premature peaches on every limb, and also many diseased shoots. There are sound peaches on one branch of one limb only.

These 19 trees were reëxamined in the autumn of 1889. All of them were then yellowish and quite badly affected. Few bore any fruit. They were again examined in the autumn of 1890. At that date all of the shoot-axes were dwarfed, many winter buds were germinating, and the trees bore no healthy foliage. The leaves were stunted and pale green, yellowish, or red. Many branches were dead, but no entire trees. They bore no fruit in 1890.

So far as I can see, the progress of the disease in these trees was not retarded by the excisions. They are now neither better off nor worse than many other cases of 1887, left for comparison. In 9, 16, and 18 the symptoms on the remaining limbs were not very numerous in 1888, but I can not be sure that such might not have been the case in any event, because sometimes the entire tree does not succumb until the third year.

C.—*Orchard of George Gildersleve, near Rising Sun, Delaware* (G. D. Jackson, tenant).—Trees set 6 years; all cases of 1887: selected out of several hundred as being freest from symptoms of yellows and, therefore, most suitable for the experiment. The trees were free-growing, thrifty specimens, and in each the disease appeared to be localized on the upper part of one limb. This was cut away next to the stem and the stump was painted.

(1) September 19, 1887. Variety, Smock. One main limb was removed; two were left.

RESULT.—August 18, 1888. One of the limbs bears premature peaches on all parts, and also many diseased shoots. The other bears green, healthy peaches, and shows no indication of disease.

(2) September 19, 1887. Variety, Smock. One limb was removed; four were left.

RESULT.—August 18, 1888. This tree bears healthy fruit and foliage on all parts, except one branch of one limb. This bears premature peaches and about 30 diseased shoots. The effects of the disease are also apparent in the spring foliage and in the terminal growths. The union of this branch with the main limb, which otherwise seems healthy, is 4 feet above the stump of the excised limb.

(3) September 19, 1887. Variety, Reeves's Favorite. One limb was removed; two were left.

RESULT.—August 18, 1888. This tree now bears only a few peaches. There were no prematures, unless a few may have ripened very early and disappeared. The foliage is healthy, and the only indications of disease are copious yellows shoots on the trunk at the earth's surface, just below the excised limb.

D.—*Orchard of John A. Nicholson, Leipsic, Delaware.*—September 21, 1887. An effort was made to cut the disease from 3 trees forming part of a 3-year-old, 39-acre orchard on the farm of John A. Nicholson, near Leipsic, Delaware. There were 19 diseased trees and I selected the ones which seemed most favorable, removing large limbs.

This orchard was not revisited, but I was told that the remainder of each tree showed yellows the following season and that there were 500 new cases.

All these experiments were begun in mid-September. The next year I repeated the experiments in other orchards, cutting away the limbs in August, *i. e.*, 5 weeks earlier.

E.—*Orchard of George Davis, Still Pond, Maryland.*—Trees set 19 years; cases of 1888; selected from about fifty as most suitable for the experiment. The trees were very large and vigorous for their age, trunks, about 1 foot in diameter; height, 25 to 30 feet. I was particular in the selection of trees and cut back very severely, wasting much good fruit. The limbs were severed next to the body of the tree and the stumps were painted.

(1) August 9, 1888. Variety, not recorded. The tree was full of peaches, nearly all of which were green and healthy. Two small branches had been cut away recently because they bore premature fruit. The large limb which had borne these branches still bore a few ripe, red-spotted peaches, but most of its fruit was healthy. This limb was cut away next the trunk, the stump being 6 inches in diameter and sound. Part of the other main limb, with much sound fruit, was also cut away because a few twigs on one branch bore premature fruit. One comparatively small limb was left. This bore green peaches and appeared to be perfectly healthy. There were yet no diseased shoots on any part of the tree.

RESULT.—September 20, 1889. Tree gone. Supposed to have been removed accidentally in spring or summer on account of disease, the order being to remove all diseased trees.

(2) August 9, 1888. Variety, Mountain Rose. A small branch which bore premature peaches had been removed recently, and another small branch on the same limb bore the ripe and red-spotted fruit. There were no other indications of disease. Even on this limb nine-tenths of the fruit and all of the foliage appeared to be perfectly normal. The limb was cut away close to the trunk. The sound stump was 7 inches in diameter. The limb which remained bore thrifty foliage and was full of green, healthy peaches. A very careful examination of all parts showed no trace of disease.

RESULT.—September 20, 1889. There is no fruit. One branch bears three diseased shoots, but the spring foliage of the tree is still normal in size and color.

(3) August 9, 1888. Variety, Reeves's Favorite. Parts of one limb showed symptoms of disease; a small branch had been cut away recently on account of yellows and two other small branches bore large, red-spotted, ripe fruits, which were in very marked contrast to the unripe peaches upon the remainder of this limb and upon other parts of the tree. Eighteen inches above the cut a feeble shoot, one-fourth inch long, was pushing through the rough bark. Eighteen inches farther up the limb was a shoot, 2 to 3 years old, which bore diseased sprouts on its base and also 6 feet above in its top. These sprouts were small, *i. e.*, recent growths. There were no other diseased sprouts on the tree, and, even on this shoot, most of the buds were dormant and most of the foliage was green and full grown. The limb which bore these premature peaches and diseased sprouts was cut away close to the body of the tree, although almost the whole of it bore only healthy fruit and all of it bore only dark-green and vigorous spring foliage. The stump was six inches in diameter and decaying at the center. One limb remained. This bore green, healthy peaches upon

all of its branches. Its foliage was also full grown, dark green, and very healthy in appearance. There was not the least indication of disease.

RESULT.—September 20, 1889. There is no fruit. This tree now bears an abundance of healthy foliage and there are no diseased sprouts or other indications of yellows—none whatever.

This tree was reëxamined October 20, 1890, and found to be diseased in all parts.* The wind had blown away the top 9 feet above the ground, but three small branches remained. These bore many diseased sprouts. The trunk also bore similar sprouts.

F.—*Orchard of George Davis, Still Pond, Maryland.*—Trees set 5 years; cases of 1888; selected out of about thirty as most suitable for the experiment. The whole orchard was thrifty and fair to look upon.

(1) August 9, 1888. Variety, Smock. Two limbs were removed; one was left. Those which were cut away bore premature peaches. The one which was left bore green fruit, and seemed to be healthy.

RESULT.—September 20, 1889. Still diseased.

(2) August 9, 1888. Variety, not recorded. This tree ramified near the ground into three main limbs. Two small branches on one of these limbs bore premature peaches. The remainder of that limb, *i. e.* most of it, and the rest of the tree, bore green, healthy fruit. There were no diseased sprouts, and no other indications of yellows, the foliage of the whole tree being green, full-grown, and healthy.

RESULT.—September 20, 1889. The tree is now diseased in all parts.

G.—*Orchard of F. H. Harper, Still Pond, Maryland.*—Trees set 7½ years; all cases of 1888; selected out of several hundred as being freest from symptoms of yellows, and therefore most suitable for the experiment. As in Mr. Greene's orchard, and elsewhere many otherwise promising trees were rejected because of slight symptoms on the base of some of the main limbs. All of these trees were free-growing and thrifty. None of the spring foliage was rolled, curled, or yellowish, except upon one tree. The fine green color and robust growth of this foliage, even on affected limbs, was very noticable. The trees were freer from symptoms of disease than at Mr. Greene's, but a larger portion of each was cut away. In fact, the excisions were very severe and wasted a great many baskets of good fruit. Roughly stated, I removed from one-third to two-thirds of the whole top of each tree, only a small portion of which in most cases showed any indications of disease. The limbs were cut close to the body of the tree, and their stumps were carefully coated with paint. These were 3 to 4 inches in diameter.

This orchard was believed to be well adapted to the experiment because of the healthful appearance of the trees, and because of the very gradual manner in which many of them had succumbed to the disease in 1887 and 1888. The cases of 1887 were dug out and removed that fall or the following spring; the cases of 1888, exclusive of the trees under consideration, were cut back to the stem that autumn, but were not removed until the end of the next growing season.

(1) August 10, 1888. Variety, Christiana. One limb was removed; two limbs were left. The excised limb bore premature fruit on a small portion only, *i. e.* two small branches. The remainder of its fruit was green and healthy. The limb was sound and there were no diseased sprouts. The fruit upon the remaining limbs was green and healthy and the foliage was excellent.

RESULT.—May 13, 1889. Apparently healthy.

September 17, 1889. Still diseased; slight symptoms upon two limbs. No fruit this year.

October 11, 1890. Tree decidedly inferior looking. Foliage, red, yellow, dwarfed, and rolled. In marked contrast to neighboring healthy trees. Tree, very twiggy; many of the small, unbranched, sickly shoots which grew early in the season have dried up. A few winter buds are now pushing, and the terminal buds on a number of shoots germinated about 6 weeks ago. No fruit this year.

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* See note to G 3.

(2) August 10, 1888. Variety, Old Mixon. One limb was removed; two limbs were left. The excised limb bore sound green peaches on nearly all parts; but there were premature peaches on one small branch. Foliage, excellent; no diseased sprouts; stump, sound. The limbs which were left bore green peaches and beautiful foliage.

RESULT.—May 13, 1889. Apparently healthy.

September 18, 1889. Still diseased, but the symptoms are slight. No fruit this year.

October 10, 1890. Plainly diseased in all parts. The spring foliage is reddish. Some weeks ago many terminal buds pushed on branches in the top of the tree, and each now bears a whorl of pale green, spindling leaves, 2 to 3 inches long. On many of these branches the lower buds have also germinated, but more recently. The same symptoms occur on a dozen shoots which have grown from the base of the main limbs. No fruit this year.

(3) August 11, 1888. Variety, Old Mixon. One limb was removed; one was left. The excised limb branched into two equal forks 16 inches above the cut. The stump was sound and the foliage on both forks was full-grown, green, and healthy. All of the fruit on one fork was green and healthy. Most of that on the other was also green and healthy, but two small branches bore ripe, red-spotted fruit, and also two diseased shoots each only about one-fourth inch long. The remaining limb bore green peaches and perfectly healthy foliage. There was not the least sign of yellows.

May 13, 1889. Doubtful. Vegetation is not far enough advanced to tell positively.

September 18, 1889. Excision apparently entirely successful. No symptoms of yellows. There are no diseased sprouts or germinating buds. The foliage also is thrifty and of the proper form and color. Half a dozen vigorous shoots have grown from the base of the remaining limb. These are 2 to 3 feet long, and bear excellent foliage. No fruit this year.

October 10, 1890. The tree is now diseased, but the symptoms are confined to one shoot. This grew in the summer of 1890 upon the base of the main limb. It is robust, unbranched, and 2 feet long. The terminal bud developed some time ago, has grown 2½ inches, and now bears a whorl of immature leaves. Below, on the same shoot, a dozen buds have germinated recently and sent out leaves which are one-fourth to three-fourths inch long.

Otherwise the tree looks as well as its healthy fellows, and but for this one shoot I should certainly think it sound.

Apparently the disease was not removed by the excision, but has hung about the tree, or been dormant in it, ever since 1888. *

(4) August 10, 1888. Variety, Old Mixon. Two limbs were removed, both from one side. On one of these limbs was a small branch bearing 8 or 10 premature peaches, on the other were two small branches each bearing 10 to 12 premature peaches. The remainder of the peaches on both limbs, 200 or more, were green and healthy. The spring foliage was abundant, full-grown, and healthy. A few small diseased shoots, one-half inch long, were pushing from the base of a small limb 3 feet above the cut. There were no other signs of disease and the stump was sound. The foliage upon

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* On September 20, 1889, Mr. J. Frank Wilson, of Still Pond, Maryland, took me to a tree in one of his older orchards, No. 4 of my first report, which then appeared to be perfectly healthy, but which he said had shown unmistakable symptoms of yellows in the fall of 1888, at which time he had cut away all but one small limb. At the date of my visit this limb seemed likely to grow into a new and healthy top. This tree was reëxamined October 15, 1890, and found to be so badly diseased in all parts that I was compelled to believe that it had not been free from disease at any time since 1888, although it developed no symptoms in the season of 1889.

Several cases similar to this one have come under my observation, but usually the period of immunity has been shorter.

the rest of the tree was entirely healthy. The peaches were numerous, green, and normal.

May 13, 1889. Apparently still diseased. Some puny-looking sprouts are growing from the base of the excised limbs and from the trunk under them.

September 17, 1889. To casual observation this tree is as healthy as No. 3, but I find scars on the stub of the excised limb from which some one has broken shoots. A search in the weeds under the tree brings to light several dried up but much-branched and quite characteristic yellows shoots, which correspond to the scars on the stub. There are no present indications of yellows, but unquestionably the tree is diseased. No fruit this year.

October 11, 1890. Most of the foliage has fallen, probably nineteen-twentieths. Some of it is redder than should be. It is not yet a bad-looking tree, although plainly diseased. Winter buds are now germinating on half a dozen shoots. I counted fourteen on one not over a foot long.

(5) August 10, 1888. Variety, Reeves's Favorite. One limb was removed ; one was left. The excised limb bore 25 to 30 premature peaches distributed on two branches. The rest of the limb bore many sound, green peaches. There were no diseased sprouts, and the foliage of the entire limb was full-grown, and of a healthy green. The limb which was left bore green, healthy peaches and healthy foliage.

May 13, 1889. Apparently healthy.

September 17, 1889. There are now slight but unquestionable symptoms of disease, *i. e.* a half dozen feeble shoots on the trunk and limbs. The spring foliage is dark green and thrifty. No fruit.

October 11, 1890. The tree is well provided with good foliage, and there are only a few diseased shoots. One is a terminal bud which has grown about one-half inch, developing a whorl of immature leaves now 2 to 3 inches long. Another is a small, feeble shoot on the trunk.

(6) August 10, 1888. Variety, Reeves's Favorite. One limb was removed ; one was left. The excised limb tri-parted a short distance above the cut ; two of the three parts bore premature peaches upon some branches and green ones upon others. The third fork bore only green, healthy fruit. The foliage of this tri-partite limb was full-grown, green, and healthy. There were no diseased shoots and the stump was sound. The remainder of the tree bore green, healthy peaches, and excellent foliage. There was no least sign of yellows.

May 13, 1889. Appears to be diseased.

September 17, 1889. At first sight this tree appears to be as healthy as No. 3. The entire foliage is vigorous and of a healthy green. Seven lusty shoots have grown out of the trunk just below the excised limb. These are 3 to 4 feet long, and most are one-half inch in diameter at the base. All look healthy and bear excellent foliage. However, on the base of the remaining limb, 4 inches from the cut, there is a scar easily overlooked. Some one wrenched a shoot from this spot in the summer. Search in the weeds under the tree brings it to light. This shoot is 2½ feet long and branched in the characteristic manner. There is, therefore, no doubt that the tree is still affected, although at present it shows no symptoms of disease. No fruit this year.

October 11, 1890. Tree much like No. 5. There is an abundance of good foliage, but upon two shoots about a dozen winter buds are now pushing.

(7) August 10, 1888. Variety, Beers's Smock. One limb was removed. This limb biparted just above the cut. On one fork two small branches bore about a hundred red-spotted peaches which were ripe or nearly ripe, while 5 or 6 others of about equal size bore only green, healthy fruit. The other fork bore nothing but healthy peaches. There were no diseased shoots, and the foliage of the entire limb had every appearance of health. The stump was sound. The rest of the tree seemed healthy. It bore sound, green peaches, and full-grown, green foliage.

May 13, 1889. There are diseased shoots at the base of the excised limb. A few have also grown from the base of the adjoining limb.

September 17, 1889. Still diseased. The symptoms are confined principally to the stump of the excised limb and to one other limb, the top of which was cut out in the spring or summer during my absence. No fruit this year.

October 11, 1890. Not recovered and not better looking than other diseased trees in the same orchard. All of the foliage which remains is unnaturally rolled, curled, red and yellow. The tree bears diseased sprouts and some of its winter buds are now pushing.

(8) August 10, 1888. Variety, Christiana. One limb was removed; three were left. The excised limb biparted 8 inches above the cut. One fork bore 230 premature peaches and only a few healthy green ones. On the lower part, pushing from the bark, were several diseased growths each only about one-half inch long. One of these was within 18 inches of the cut. The spring foliage was full-grown, dark-green, and healthy. The winter buds were dormant and there were no other indications of disease. The other fork, which was of the same size or a little larger, bore healthy foliage and between two and three hundred healthy, green peaches. The limbs which remained appeared to be perfectly healthy. They bore only green peaches and healthy-looking foliage.

May 13, 1889. Apparently still diseased. There are some feeble shoots with reddish foliage on the main limbs near the trunk.

September 17, 1889. The symptoms of yellows are more apparent on this tree than on any of the preceding seven, yet the tree would not be called badly diseased. There is no fruit to judge by, but the spring foliage on the entire tree is somewhat curled and yellowish. There are also a number of feeble shoots, and winter buds are now germinating in a number of places upon both the main branches of a limb opposite to the one which was excised.

October 11, 1890. Most of the foliage has fallen; what remains is unnaturally rolled, curled, and red. The tree is rather twiggy from last year's diseased shoots now dead. On one branch and on one stem-shoot, the winter buds are now germinating. Not many diseased sprouts appeared this year and the tree has made a fair growth.

(9) August 10, 1888. Variety, Old Mixon. One limb was removed; two limbs were left. The excised limb biparted 14 inches above the cut. The larger fork bore 100 to 200 healthy, green peaches; the smaller fork bore about one-half as many premature peaches, but also some green ones on the top branches. A few sprouts near the base of the smaller fork are not quite healthy, and the smallest, which is only about one-half inch long, is not over 2 feet above the cut. The stump was sound, and the spring foliage on the entire limb was full-grown and healthy. The peaches and foliage on the remaining limbs were perfectly healthy in appearance.

May 13, 1889. Signs of disease are now visible on the trunk just below the stump of the excised limb.

September 17, 1889. Still diseased. A tuft of yellowish, much-branched, feeble sprouts has grown from the stub of the excised limb. One of the main limbs bears diseased growths at its base, 6 feet above, and on the extremities of several branches, at a distance of over 10 feet from the trunk. The other main limb looks healthy, except that the terminal buds on two thrifty "watershoots" began to grow in August, something very unusual in healthy peach trees in this climate, although not uncommon in Georgia in midsummer. The spring foliage on both limbs continues to look healthy.

October 11, 1890. Most of the foliage has fallen. The remainder is unnaturally reddish. Terminal buds pushed some time ago in the top of the tree, and several lusty stem-shoots are now full of germinating buds.

(10) August 10, 1888. Variety, Reeves's Favorite. One limb was removed. It

bore 20 to 30 green peaches and about the same number of fully-ripe ones,* but none of the latter were within 10 feet of the cut. There were no diseased sprouts or germinating winter buds. The foliage was full grown and entirely healthy. The remaining limbs bore healthy peaches and excellent foliage. One small shoot, however, on the base of the east branch, did not appear quite right, yet I could not say it was affected by yellows. It was 14 inches long and unbranched. The leaves were somewhat paler than normal and were attacked by a shot-hole fungus, which is quite common on the leaves of diseased trees.

May 13, 1889. The entire top was blown away by a tornado which occurred soon after the excision, but the stubs of the limbs appear to be diseased.

September 17, 1889. Numerous yellowish, much-branched, feeble, spindling shoots have grown from the stub.

October 11, 1890. The trunk is now dead.

(11) August 10, 1888. Variety, Reeves' Favorite. One limb was removed. This subdivided 2½ feet above the cut into four branches, three of which bore a few large, ripe peaches, while the fourth bore about twenty green ones. The proper time for the ripening of this variety in that orchard is August 20. The foliage was full grown and healthy looking, and there were no diseased shoots either from winter buds or obscure buds.† The stump was sound. The remaining limbs bore healthy, green peaches and excellent foliage. There was no sign of yellows.

May 13, 1889. The entire top was blown away by the tornado. There are no vigorous shoots on the trunk or stubs of the limbs, but only three or four buds pushing feebly and two small, dried-up shoots. The stump looks nearly dead, but this is probably due in part to the effect of the wind.

September 17, 1889. Dead. No growth of any sort since spring.

(12) August 10, 1888. Variety, Reeves' Favorite. One limb was removed. This bore about twenty large, showy, ripe peaches, and about the same number of much smaller green ones—all of the latter upon one branch. There were no diseased shoots; the foliage was healthy; and the stump was sound. The remaining limbs appeared to be healthy. They bore green peaches and vigorous foliage.

May 13, 1889. Doubtful; a feeble shoot is pushing just beneath the stub of the excised limb.

September 17, 1889. The tree is diseased, but the symptoms are slight and confined to the trunk. There is a diseased shoot 6 inches below the excision, and another stouter one on the margin of the cut. The winter buds upon the latter are now germinating. The foliage of the entire top looks healthy and is vigorous for the time of year. Had these two shoots been removed prior to examination, or had they never grown, any one would have pronounced the tree entirely healthy.

October 11, 1890. Still diseased. Most of the foliage has fallen; what remains is abnormally reddish. Numerous winter buds are now germinating upon two shoots.

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*The premature peaches on this tree, like those on all the others, were large and showy; the skin was red-spotted and high colored; the flesh was also much streaked and spotted with bright red. Many of these spots were to be seen on radial as well as tangential sections. They were about one-sixteenth inch in diameter, and were not confined to the fibro-vascular system, but formed part of the ordinary parenchyma of the fruit. The streaks of color were limited principally to radial sections, but did not extend from from pit to skin. Some of these peaches tasted very well; others were insipid or sickish. Sometimes, even, one-half of a peach tasted well and the remainder was not palatable.

†Upon the diseased trees in this orchard there were fewer yellows shoots in 1888 than in 1887. This was also true for all the other orchards in that region. It was correlated with dry weather, which also had its effect upon the total growth. At least, in this orchard, where I examined most particularly, the healthy terminal growths of 1888 were considerably shorter than those of 1887. There have been rather more cases, however, in the dry seasons than in the wet ones.

(13) August 10, 1888. Variety, Reeves' Favorite. One limb was removed; two limbs were left. The excised limb bore about a dozen large, ripe peaches and more than one hundred green ones. There were no diseased shoots; the foliage was full grown and vigorous and the stump was sound. The remaining limbs bore healthy, green peaches and excellent foliage.

May 13, 1889. Apparently diseased, *i. e.*, there are a few feeble shoots on the trunk, but it is too early in the growing season to decide positively. One large limb was blown away by the tornado.

September 17, 1889. Still diseased. There are a few sickly shoots on the base of the trunk below the excision, but some robust, healthy-looking shoots also grow from the vicinity. Diseased shoots also grow from beneath the base of the limb which was blown away by the tornado. The crown of the tree still bears full-grown, dark-green foliage, but on one branch some of it curls and droops a little. There are no other signs of disease. No fruit this year.

October 11, 1890. The tree is well provided with good-looking foliage, but diseased sprouts have grown from the base of the trunk, and many winter buds are now germinating. No fruit.

(14) August 10, 1888. Variety, Old Mixon. Two limbs were removed, *i. e.*, about two-thirds of the whole top; and two were left. One of the excised limbs was loaded with peaches which were ripe, and red-spotted on the skin and in the flesh. The other limb biparted one foot above the cut. The larger fork was loaded with ripe peaches; the smaller one bore many green peaches and only a few premature ones. This smaller fork had lost a branch and was dozy at the heart from that point downward for a distance of 3 feet, rain having entered. One stump was sound; the other showed two small dozy spots in the center, the result of the downward movement of the decay which began at the base of the broken branch. There were no diseased shoots and the foliage was healthy. The remaining limbs were healthy, *i. e.*, seemed to be. The peaches were green, and the foliage was excellent. I mention condition of stumps because yellows has been attributed to injuries. In this connection it may be noted that these trees were covered with smooth, sound bark and were very free from injuries of any sort on any part, limbs, trunk, or roots. The entire orchard has escaped the attacks of the borer (Ægeria) to a remarkable degree. Most of the trees used in this experiment were entirely free from them and had always been so while none of them had been seriously injured. Possibly the character of the soil has had something to do with this immunity. I find this insect most troublesome upon sandy or friable soils. On the light sands of Sussex and Caroline Counties the borers have to be removed once a year and sometimes twice. Otherwise the orchards would soon be destroyed.

May 13, 1889. Apparently still diseased. The suspicious appearances are upon the trunk near where the limbs were removed.

September 17, 1889. Still diseased. Six inches below the lowest excision there is a feeble, much-branched yellows shoot. The smaller limb was blown away by the tornado. The remaining limb is now plainly diseased. Its spring foliage is full grown, but lighter green than should be, and is somewhat inclined to droop and curl. There are also well-marked, feeble yellows shoots on several branches at distances of 8 to 10 feet from the excision. No fruit.

October 11, 1890. Most of the foliage has fallen; what remains is abnormally reddish. The tree is twiggy, and there are signs of disease in the top. One stem shoot also bears fifteen buds, which have germinated recently. No fruit this year.

(15) August 10, 1888. Variety, Christiana. Two limbs were removed, both from one side; one limb was left. Nearly all of the fruit on both of the excised limbs was premature; on both limbs 3 feet above the cut diseased shoots had pushed through the rough bark, but were only from one-half inch to 2 inches long. On one of the limbs at the same height there were also stout, healthy-looking shoots of this season's growth. The other limb bore an additional 15 or 20 feeble shoots 5 to 8 feet above the

cut. These were 1 or 2 inches long and had also developed from obscure buds buried in the bark or formed in the cambium. The stumps were sound and the spring foliage was healthy. The remaining limb bore green peaches and healthy foliage, but I had little hope of saving it, owing to the number of branches which manifested symptoms.

May 13, 1889. Apparently still diseased. A number of feeble shoots are pushing on the base of the limbs.

September 17, 1889. Still diseased. Half a dozen lusty shoots have grown from the the base of the remaining limb, and three of these are much branched, feeble at the extremities, and badly diseased. The leaves upon the crown of the tree are of normal size and color, but are somewhat curled.

October 11, 1890. The spring foliage is of good size, but it is unnaturally rolled and curled, reddish and yellowish-green and unhealthy looking. The winter buds are germinating upon four different shoots, in the same manner as shown in Fig. 1, Plate III.

(16) August 10, 1888. Variety, Old Mixon. Two limbs were removed, both on one side. Each of the excised limbs bore a few high-colored, red spotted peaches, and a much larger number of green ones. About 4½ feet above the cut one branch bore a few small unbranched, but diseased sprouts. There were no others on the tree. The stumps were sound. The remaining limbs bore many green peaches and excellent foliage. There was no trace of yellows.

May 13, 1889. Apparently still diseased. The suspicious shoots are on the base of the main limbs.

September 17, 1889. The tree is still diseased, and in all parts. Numerous, branched, feeble shoots have grown from the trunk and from the stubs of both excised limbs. These feeble shoots also occur on all of the larger branches and even in the top of the tree. The spring foliage is curled and yellow. This tree is much worse than any yet examined. No fruit this year.

October 11, 1890. Nineteen-twentieths of the foliage has fallen; what remains is rolled, curled, and very red. The winter buds are now germinating on a dozen different shoots. No fruit in 1890.

(17) August 10, 1888. Variety, Reeves' Favorite. One limb was removed. This biparted 10 inches above the cut. The larger fork bore healthy, green peaches and the smaller one bore 20 to 30 ripe peaches, which, however, were confined to two small branches. There were no diseased shoots. The stump was sound and the foliage was luxuriant. The remaining limbs were loaded with green peaches and the foliage was like that of the excised limb.

May 13, 1889. The entire top was blown away by the tornado of Aug. 21, 1888. Apparently, the stubs of the limbs are still diseased.

September 17, 1889. Branched, diseased growths now cover the whole upper part of the trunk. They have grown from the stubs of each limb, and also very abundantly from several places on the body below the excision. On the trunk they are very wiry and feeble.

October 11, 1890. This stub is trying hard to live. It now bears thrifty shoots, provided with an abundance of foliage of normal size and nearly natural color, which is now yellowing and nearly ready to fall. But it also bears a half-dozen spindling, sickly, branched shoots, and winter buds are now pushing on a number of others.

(18) August 10, 1888. Variety, Reeves's Favorite. One small limb was removed; two larger ones were left. The excised limb bore ripe and nearly ripe peaches on many branches, and bore no green fruit. There were some small, diseased shoots well out upon one branch, and a feeble shoot one-fourth inch long had developed from an obscure bud and pushed through the bark only 1 inch above the cut. This was not discovered in time or the tree would have been rejected. The spring foliage was full grown, but in places it began to look yellowish. The stump was sound. The remainder of the tree was full of green peaches and healthy foliage.

May 13, 1889. Doubtful. A few feeble shoots are growing on the trunk below the stub of the excised limb, and on the base of another limb.

September 17, 1889. Symptoms of yellows are now present. From the stub of the excised limb have grown two much-branched, feeble shoots upon which winter buds are now germinating. Such a shoot has grown also from the trunk, 14 inches below the cut. There is also a small, diseased shoot on the base of a main limb, 12 inches above the excision. Otherwise the tree appears to be healthy. There was no fruit this year.

October 11, 1890. The foliage is abnormally reddish, and the winter buds are now germinating upon two large shoots, which have grown from the base of the main limbs. No fruit in 1890.

(19) August 10, 1888. Variety, Reeves's Favorite. One limb was removed. Two small branches bore ripe, red-spotted fruit. These branches joined the main limb about 8 feet above the cut. Six other branches of about the same size bore green peaches. The entire limb bore full-grown, dark-green foliage; and there were no diseased shoots. The stump was sound. The remaining limbs bore healthy, green peaches and excellent foliage.

May 13, 1889. There are a few sprouts of uncertain character on the stub of the excised limb. Otherwise the tree appears to be healthy.

September 17, 1889. The top bears good foliage and looks healthy, but several branched and feeble diseased shoots have grown from the stub of the excised limb. There is no fruit, and I can find no certain indications of disease on any other part of the tree.

October 11, 1890. For the time of year there is more than the usual amount of foliage on this tree, and it is of better size and color, and less curled than on many of the trees. However, several terminal buds have pushed in the top of the tree, and winter buds are now germinating on six different shoots which have grown from the base of the main limbs. One of these shoots pushed twenty-eight buds in late summer or early fall. These made a spindling growth of 2 to 4 inches, and are now dead. On the same shoot sixteen additional buds are now germinating. There was no fruit in 1890.

(20) August 10, 1888. Variety, Old Mixon. One limb was removed; three limbs were left. The excised limb bore premature peaches on nearly every branch. One diseased shoot, one-eighth inch long, was pushing through the bark about 2 feet above the cut, and a half dozen others, one-eighth inch to 1 inch long, were visible higher up. There were no others, and the spring foliage was healthy. The remaining limbs were full of healthy foliage and green peaches, which Mr. Price said ought to ripen from 9 to 12 days later.

May 13, 1889. Doubtful. There are some indications of disease near the stub of the excised limb.

September 17, 1889. The tree is now badly diseased. A half dozen rank-growing branched yellows shoots have pushed from the trunk below the excision and from the base of the limbs above it. Feeble yellows shoots are abundant on both main branches of one limb all the way to the ends of the twigs in the top of the tree, *i. e.*, 12 feet above the excision. The spring foliage on this limb is also dwarfed, curled, and yellowish. On another limb the spring foliage is normal, but there is a diseased shoot at its base, and another about 3 feet up. The third limb appears to be entirely healthy. No fruit.

October 11, 1890. The foliage is very red and unhealthy looking, and sickly shoots have grown not only in the top of the tree but also next to the roots and on the base of the limbs; and winter buds are now germinating. The tree bore no fruit this year.

This closes the excision experiments. The results varied considerably, but in no case did the removal of affected parts stop the progress of the disease. The symptoms appeared again the following season in all but two of the trees, and in these two they came back the second season. Even when the entire top was removed, as by the tornado in G 17, the disease quickly reappeared.

The inference that the disease was really cut out and that all these cases are *reinfections* is inadmissible, because nothing of a similar nature occurred elsewhere in the orchards. To establish this we have only to trace the history of these trees for 1 year from the date of the excisions, and to compare that with the history for a similar period of other trees in each orchard, *i. e.*, those which were healthy when the excisions were made.

In Mr. Greene's orchard 100 per cent of the excised trees showed fresh symptoms of the disease in 1888, but only about 12 per cent of the others became affected; *i. e.*, the new cases in 1888 amounted to only 12 per cent of the whole number of healthy trees. In Mr. Harper's orchard 95 per cent of the excised trees showed fresh symptoms of the disease in 1889, but only about 2 per cent of the others became affected. Most of the excisions were made in these two orchards, and no record of cases in the other orchards was kept for comparison.

In a few instances I have known 50 per cent of the trees of an orchard to become affected with yellows in 1 year, but never 100 per cent, and very rarely more than 15 to 25 per cent, even in the worst affected districts. It would seem, therefore, that the disease persisted in these trees, *i. e.*, that the symptoms subsequent to the excisions were not the result of reinfection.

It remains to ask whether the excisions exerted any retarding influence. One year from the date of the excisions the trees in Mr. Harper's orchard were freer from symptoms of yellows than had been those in Mr. Greene's orchard (Experiment B), and the same relative difference was apparent at the end of the second year. It might not be proper, however, to draw the inference that the development of the disease was slower *on account of the excisions.* There is some doubt as to whether the excisions retarded the progress of the disease, for the following reasons: (1) The trees manifested only very slight symptoms to begin with, *i. e.*, much slighter than the trees in Mr. Greene's orchard; (2) They bore no fruit in 1889 or 1890, whereas the trees in Mr. Greene's orchard experienced the strain of a large crop in 1888, and of a partial one in 1889; (3) The natural progress of this disease is sometimes very slow, requiring a third season for the development of the symptoms in all parts of the tree. It is therefore not impossible that the disease might have progressed in these particular trees with the same slowness, had no limbs been removed. The most that can be said is that the severest excisions, *e. g.*, those in Mr. Harper's orchard, *appeared* to exert a retarding influence on the progress of the disease.

Of course, the results obtained do not preclude the *possibility* of cutting out the disease in some cases. The evidence to the contrary is, however, reasonably conclusive, and sufficient for all practical purposes.

The experiments also throw considerable light upon the nature of the disease but do not settle the question as to whether the disease is latent in the *whole* tree when symptoms appear in any part of it. This will require additional experiments of another kind.

IV.—OBSERVATIONS AND EXPERIMENTS BEARING UPON IMMUNITY.

(1) The question of immunity is a very important one. If we could somewhere find peach trees hardy enough to resist this disease, a great practical problem would be solved. It has been said that seedlings are much less subject to yellows than budded trees. In the localities where I have studied this disease seedling orchards are infrequent, but from what data I have been able to gather I should say that seedling trees derived from budded fruit are equally subject.

On the Delaware and Chesapeake peninsula the belief is also pretty general that budded trees imported into diseased districts from healthy localities are as much subject to yellows as those grown at home, or at least do not escape the disease. On the other hand, I have been told by growers that they have had little trouble from yellows since they have formed the practice of selecting their own buds and stocks. The well-known habit of certain nurserymen to buy trees wherever they can, and sell them again as their own stock, obscures what would otherwise be a somewhat simple problem. In many cases in studying orchards it has been difficult to determine the origin of the stocks, and impossible to learn anything about the location or character of the trees from which the buds were taken. Because nursery stock was grown in a locality free from yellows it by no means follows that the buds came from the same locality. Buds are often procured directly from a distance, or are taken from young trees recently introduced into a neighborhood. In case of new varieties, I have several times known trees to be propagated from young trees recently introduced from localities where this disease is very prevalent. In buying trees much depends upon the integrity of the nurseryman, which is often an unknown factor and sometimes a negative quantity.

The fact that growers in the diseased districts have bought trees from a good many nurserymen with pretty much the same results is tolerably strong evidence, although not entirely conclusive.

A knowledge of these facts led me to plan an experiment in which I should know in advance the character of the stocks and the buds, and be able to watch the behavior of the parent trees as well as the progeny so long as might be necessary.

(2) EXPERIMENT 1.—The trees for this series of inoculations were 1,000 Mariana plums rooted by J. W. Kerr, at Denton, Maryland, in the spring of 1888 from cuttings made in his own orchards. They were divided into five lots and inoculated in August, 1888, with buds taken from five healthy peach trees also in Mr. Kerr's own orchards. These

five trees were carefully located and have been under observation ever since. I examined them particularly May 23, 1890, making the following memoranda:

The character of the trees from which came the buds used in working the peach on plum roots is as follows, all of the buds of one variety having been taken from one tree:

(1) *Old Mixon.*—Exact origin unknown; set out by T. A. Smith, of Denton; age, 38 years; entirely free from yellows; foliage of a healthy green.

(2) *Crawford's Early.*—Budded by Mr. Kerr from a bearing tree in Caroline County; set in 1874; entirely free from yellows; foliage vigorous.

(3) *Mountain Rose.*—Budded by Mr. Kerr from a bearing tree n Caroline County; set in 1876; entirely free from yellows; foliage vigorous.

(4) *Crawford's Late.*—Budded by Mr. Kerr from a bearing tree in Caroline County; set in 1876; entirely free from yellows; foliage vigorous.

(5) *Beers' Smock.*—Budded by Mr. Kerr from a bearing tree in Caroline County; set in 1876; entirely free from yellows; foliage vigorous.

These trees are old and broken, but they are not diseased.

The entire orchard was examined at that time. It contains about 500 trees. They remind me of trees in the old orchards at Seaford, Delaware. Like them they suffered severely during the winter of 1881–'82,* and are rough, broken, shaggy with lichens, and frequently two-thirds dead. Here and there a tree is missing. Others have lost their entire top, healthy growths from the trunk having partially taken its place. The foliage on all was green and thrifty. There were no cases of yellows and no suspicious trees. All of the younger orchards on the same farm were likewise examined with a similar result.

This experiment is the only one in which I did not superintend the inoculations personally. At that time other duties engaged my attention, and having entire confidence in Mr. Kerr, I trusted it entirely to him, being assured that all the details would receive his personal atention.

Yellows has never appeared in any orchard on his farm, or in any on the adjoining farms; was not reported from Caroline County until 1887 is still rare in that county; and is not certainly known to occur any where in the immediate vicinity of Denton. If cases do exist at Denton, they must be sporadic and rare. Otherwise I must have seen them or heard of them. Such being the conditions, I could at the date of these inoculations think of no place where one would be more likely to secure buds free from any taint of yellows.

A hailstorm in June, 1889, destroyed the tops of many of these trees. The remainder were removed from the nursery in November of that year, and were planted in three badly affected orchards farther up the peninsula.

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* The severity of that winter killed the dormant peach buds in Caroline County, Maryland,—a thing never known before or since. It also injured the wood of many limbs. The same injuries occurred at Seaford, Delaware. However at neither place did yellows supervene, and the belief that this disease is due to autumn frosts or severe winters is wholly untenable. There is not one fact offered in support of this view which may not be explained equally well in other ways.

(*a*) The trees which went to James W. Green, Magnolia, Delaware, were set in the southwest corner of an orchard on his home farm, No. 14, map IV, of my first report. Yellows appeared in this orchard in 1886 and has been very destructive, more than 50 per cent of the trees having become affected. The disease is also very prevalent in neighboring orchards, including a younger one on the same farm. The spot selected was specially adapted to the experiment, because the disease first appeared in that part of the orchard, and speedily involved many trees. In 1889 this corner of the orchard contained very few healthy trees, but none had been dug out, and none were entirely dead. The diseased trees were removed in March, 1890, and the land then received a heavy dressing of barnyard manure, *i. e.*, over 100 loads. The young trees, which had been trenched in over winter, were then set in the spots previously occupied by the affected trees, each being given a handful of phosphate. One hundred and thirty-six trees were sent to Mr. Green (94 Beers' Smock and 42 Old Mixon), but only 124 were set. Some were quite small, but all were healthy. The Smock trees were planted next the highway.

These trees were under observation from time to time during the growing season and were critically examined September 18, 1890. Only 47 had made a satisfactory growth. Of the remainder, 24 were dead and 53 were dwarfed and yellowish as though suffering from defective nutrition. None, however, showed any signs of yellows. These trees received good cultivation, were not shaded, and did not appear to be suffering from root aphides. They had been set very deep, and I was at a loss to account for the appearance of the sickly ones, unless this might have to do with it. Later, I discovered that in all of the dwarfed and yellowish trees the tops had overgrown the stocks, and that in all the vigorous trees the growth of the stocks had kept even pace with that of the tops. The dead trees were killed in spring by the black peach aphis, which sapped and smothered the tender shoots.

(*b*) The trees which went to F. H. Harper, Still Pond, Maryland, were planted in the east end of one of his orchards on the Howard farm, No. 6, map II, of my first report, in places made vacant by the removal of diseased trees. This orchard also appeared to be a good place to try the resisting power of healthy trees. Yellows first developed in 1886 and is still present, the cases having amounted to over 25 per cent of all the trees. The disease is also very prevelant in other orchards in the vicinity, including a younger one on the same farm.

Mr. Harper received 125 trees—50 Mountain Rose and 75 Crawford's Late. All were healthy, of medium size, and in good condition for planting. Part of them were set in November and the remainder in early spring. In some cases the diseased trees were removed just previous to this planting; in others, they had been out for a year or two.

The peach upon plum were not set in a body, but were scattered among the large trees.

I saw them the last of May, 1890, at which date they looked more promising than either of the other plantations. They were reëxamined October 11, 1890, but many were choked and overgrown by weeds so as to be scarcely visible. Part of them had also been injuriously shaded by the older trees. Some were dead and very few had made a satisfactory growth, but none were suffering from yellows. Their bad appearance was attributable in part to neglect. Young trees set into older orchards require special care.

(*c*) The remainder of the trees—75 Mountain Rose, 100 Crawford's Late, and 107 Crawford's Early—were set on Dr. W. S. Maxwell's farm, at the mouth of Sassafras River, Kent County, Maryland. The 2 acres selected for this orchard are on a level hilltop, overlooking orchards No. 1 and No. 18 of my first report. This field seemed very well adapted to the experiment, having been already once in orchard and being in the center of a region of diseased orchards. The remnants of the first orchard, about 75 trees in all stages of yellows, were removed in the spring of 1890. They were then 9 years old, *i. e.*, set 9 years, and were the last to become affected. The rest of the trees had succumbed earlier and were dug out at various times, most of them in 1888. The trees had grown vigorously and were large.

The peaches on plum roots were received November 7 and were set the same day, midway between the places occupied by the old trees. Three-fourths of these trees were very fine; the rest were small. They were set shallow with a view to lessening the attacks of borers.

About one pound of unleached, hardwood ashes was distributed around each tree at planting, and tomatoes with phosphate were grown in the field in the summer of 1890.

The black peach aphis appeared upon the tops of these trees in early spring, and destroyed many of them. The remainder were seen as late as the last of May and then promised well.

These trees were reëxamined October 8, 1890. At that time 88 were dead, mostly from the attacks of the black aphis. Of the remainder, 42 were stunted and yellowish like similar trees in Mr. Greene's orchard, while 152 were very thrifty and still bore dark-green foliage. In the former, in every case, the peach top had overgrown the plum stock, producing a distinct bulge. In the latter the stocks had kept even pace with the growth of the tops, and the abundant foliage was still vigorous. In fact I have seldom seen finer yearling trees. Photos 1 and 2, plate XXVII, were made October 18 from representative trees of each group. None of these trees showed any signs of yellows.

The five trees which furnished the buds were reëxamined very carefully July 22, 1891, *i. e.*, 3 years from the beginning of the experiment. They were still entirely free from yellows, or any symptoms suggestive of that disease, and were more vigorous than in 1890, owing to the turning under of a crop of scarlet clover.

Of course, it is impossible to predict the results of this experiment. We must wait and see. I shall continue to watch the parent trees as well as their progeny. I feel reasonably confident that trees with sound constitutions have been secured, and I know beyond a doubt that they are in excellent locations to test their resisting power.

(3) A twice repeated effort to introduce a sound race of peaches from Turkestan has miscarried. It seemed like an easy matter to procure peach stones in quantity through our consul at Teheran, but it has proved very difficult. The second attempt was made in 1889 through the Department of State, but with no better results.

It appears to me safer to import stones than trees. If the latter are introduced, great care should be exercised to avoid the introduction at the same time of animal and vegetable parasites which might prove worse than the yellows. The history of the introduction of the cottony cushion scale into the orange groves of California, and of phylloxera, peronospora, and black rot into the vineyards of Europe ought to be sufficient warning. The danger is a very real one.

In Mediterranean countries and also in Australasia there is a fruit fly (*Tephritis*) which once introduced into this country would work great mischief. It deposits its eggs in the fruit after it is nearly full grown, and these hatch into swarms of maggots, which pupate in the ground. Externally the fruit is said to be fair, but within it is disgusting corruption. The peach is specially subject to this fly, but apples, pears, plums, and other fruits are also attacked. The loss is great and no remedy is known. In Japan there is a codlin moth which is said to affect 90 per cent of the ripe fruit. This insect probably occurs also in China. In the Australasian region there is also a very destructive root fungus, not confined to the peach. The mycelium of this fungus creeps through the soil long distances destroying almost every green thing in its path. There is also an obscure peach disease fully as destructive as yellows and apparently of a totally different character. The orchards of the north island of New Zealand have been almost completely destroyed by it, and it probably occurs elsewhere in that region.

This enumeration by no means exhausts the list of parasites which might be introduced into this country with imported peach trees. As the case stands we have enough of our own without importing any.

(4) Additional experiments will be necessary to determine what proportion of cases are attributable to the careless selection of buds. Yellows is undoubtedly communicated in this way, but it must spread in other ways. I have known many orchards of budded fruit where the trees flourished and bore abundantly for 15 or 20 years, or even longer, before the disease appeared. In such cases, admitting the contagious nature of the disease, we are driven to one of two conclusions: the cause of the disease has entered the tree from without, or has been dormant in it from the time it was budded. The former is reasonable; the latter is absurd, especially in the light of the comparatively speedy results obtained from inoculations.

One of the most striking examples which has come under observation is a tree on the home farm of James S. Harris, near Still Pond, Maryland. Since one case in point is as good as many, I have been at some pains to learn the history of this tree. This tree is 36 years old. It is one of a number of accidental seedlings which came up from stones thrown out in the fall of 1854. It then stood back of an old shop. This was afterwards removed and other changes made so that for quite a good many years the tree has stood in sod ground, in the lawn, somewhat isolated from other peach trees. It was budded by Mr. Harris himself in the fall of 1855, and has been under his observation and care ever since, with exception only of a few years when he did not reside on this farm. The variety is Crawford's Early. The tree has been hardy and productive. Its last crop was in 1888, since when, in common with other trees in that region and owing solely to unfavorable seasons, it has borne no fruit. The tree is about 25 feet high and has a good top; the trunk is nearly a foot in diameter and still quite well preserved. I have seen this tree each year since 1887, and always it seemed to me good for another 10 years. This tree was budded from a neighboring tree when there was no yellows in the vicinity. Some years after, perhaps 10, the disease appeared and gradually destroyed many younger trees upon the same farm, one of the badly affected orchards being within a stone's throw of this tree. The disease has increased from that time to this, and has been very destructive for the last 5 or 6 years in all that region. This old tree, however, kept on the even tenor of its vigor until the summer of 1890. Then for the first time it developed unmistakable symptoms of yellows on one small limb (plate XXVIII). Next year, undoubtedly, the disease will be manifest on other limbs if it does not involve the whole tree.*

Admitting the contagious nature of yellows, and this, I think, can be doubted no longer, I am at a loss to explain the appearance of the disease in middle-aged and old trees except by infection from without. If such be the case, then, of course, every tree which becomes affected is a fresh source of danger, and ought to be removed and destroyed as soon as possible.

V.—CONCLUSIONS.

The intelligent reader will draw his own conclusions. It is not out of place, however, for me to present my view of the case. This is as follows:

FACTS ESTABLISHED.

(1) The disease is contagious. It seems to me that Experiments 1, 2, and 5 settle this point beyond dispute.

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* Examined July 24, 1891. The diseased limb and the adjoining healthy one have been removed and the remainder of the tree shows no symptoms. The tree bears green peaches.

(2) It may be conveyed by seemingly healthy buds when these are taken from diseased trees. This is proved by Experiments 2 and 5.

(3) Only a very small amount of infective material is necessary, provided it be in the forms of living cells, which can be induced to unite with the actively growing tissues of the tree.

(4) The disease has a longer period of incubation than we have been accustomed to suppose. (See Experiment 2, especially Table I, columns 5 and 6, and plate XVIII, Fig. 1. See also the Excisions, especially B 16, 18; E 3; G 3, 4, 5, 6, 12, 19; and the note under G 3.)

(5) The death of the entire tree occurs, ordinarily, only after a very considerable period, *i. e.*, several years.

HYPOTHESES RENDERED PROBABLE.

(1) The whole tree is affected when symptoms appear in any part of it. This inference rests upon Experiment 2; a small part of Experiments 4 (?) and 5; and almost all of the excisions, 52 in number. It is hoped that experiments now under way will settle this point definitely.

(2) In some cases, perhaps in many, the period of incubation, *i. e.*, the time between the insertion of a diseased bud and the appearance of the disease, is longer than any yet clearly established. This is suggested by many things, especially by the behavior of some of the Barnard trees (Experiment 4); by the Excisions E 3, G 3, and the Wilson tree; and by Professor Goff's tree.

(3) The disease is also communicated to budded trees in some other way than by bud inoculation. This is probable in case of many young trees, and is almost certain in case of old trees. In some of my experiments the period of incubation was very considerable, and this is one of the striking peculiarities of yellows, but it is too brief to account for the appearance of the disease after the second or third year, except possibly in case of some of the trees budded at Colonel Barnard's. The evidence in favor of outside infection becomes stronger in proportion as a tree gets older. Of course, it goes without saying that additional experiments may demonstrate the period of incubation in some cases, and perhaps in many, to be much longer than any yet established.

(4) The trees are not infected through the blossoms. This is inferred from the result of the excisions, and from the fact that, in some cases, the disease appears to develop between fall and spring, and to stimulate the blossoms themselves to an unnaturally early development. About fifty cases of this kind came under observation during the very mild winter of 1889–'90, and many additional ones in the spring of 1891.

(5) Since diseased trees have been shown to be very full of infectious matter it must be that for unknown reasons much of this fails to find an immediate entrance into healthy trees. Otherwise the peach would soon disappear entirely.

INQUIRIES SUGGESTED BY THE FOREGOING EXPERIMENTS.

Three special lines of inquiry are now under consideration, and will receive undivided attention as soon as the laborious experiments with fertilizers have been completed. These are as follows:

(1) The period of incubation of the disease prior to its first appearance, *i. e.*, the greatest length of time a tree may be affected before it shows any symptoms of yellows.

(2) The exact nature of the contagium.

(3) Its method of spread other than by bud inoculation.

PART II.—PEACH ROSETTE.

I.—INTRODUCTORY.

The second part of this report will be devoted to a peculiar disease prevalent in Georgia, and first referred to as probably a Southern variety of peach yellows,* but since described under the name of *The Peach Rosette.*†

The disease does not appear to be due to any ordinary fungus, or to insects. In some respects it is quite like peach yellows, but in others it differs very materially. This year additional observations have confirmed the belief that it is a disease distinct from yellows, and I shall so consider it until proof to the contrary is forthcoming.

(1) *Plants attacked.*—As stated elsewhere (*l. c.*), the Rosette attacks many varieties of peaches. None appear to be exempt. It occurs in budded fruit and seedlings. The latter do not escape even when growing in fields and thickets without cultivation. This disease is not confined, however, to the peach, but also occurs in plums—budded trees and seedlings, cultivated, uncultivated, and wild, and is equally destructive. I have not seen it in varieties of *Prunus domestica* or in the Mariana, but it occurs in the wild *Prunus Chicasa*, in the Cumberland, and Wild Goose, and also in the Japanese varieties known as Kelsey and Botan. Probably the disease is capable of attacking many other sorts, and requires only a suitable opportunity.

This year in an orchard near Griffin, Georgia, which I know to have been nearly free from disease in 1890, and quite thrifty and well cared for, I counted about 40 bad cases of rosette, divided nearly equally between Kelsey and Botan. These trees were 5 or 6 years old, and the loss must have been considerable.

(2) *Characteristics of the disease.*—As in peach yellows, this disease not infrequently attacks one or two branches only at first, but in a much larger per cent of cases, the whole tree is diseased from the start, and the disease runs its course in a much shorter time. Six months is usually sufficient to destroy a tree, and I have known no cases to last

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* Peach yellows: A preliminary Report, U. S. Dep. Ag. 1888.

† The Journal of Mycology, Vol. 6, No. IV.

more than two seasons. Such a thing as the lingering on of a diseased tree from year to year, as in peach yellows, is not known. I have seen trees completely diseased in June and dead in November, which first showed symptoms in early spring and were in apparently perfect health the preceding autumn. This is the common course of the disease.

When a tree is attacked in part, the shoot-axes and foliage of the remaining limbs often appear to be perfectly healthy, but these limbs always develop rosettes, and die the following year. Not infrequently I have observed the disease to progress gradually from the affected side to the healthy, *i. e.*, the parts on the healthy side first to be attacked being the bases of the limbs. The bark of trunk and limbs on affected trees presents no peculiar or symptomatic differences. Undoubtedly there are changes in the cambium cylinder corresponding to the shortening of the terminal shoot-axes, but these are not visible externally.

The following are some of the more noticible symptoms:

(*a*) *Young shoot-axes.*—Commonly the disease first appears in the unfolding shoot-axes, *i. e.*, in early spring when the buds first open. In healthy trees only a small proportion of the winter buds develop into branches. The rest die or remain dormant. In this disease a very large part of the winter buds grow into shoot-axes and also a very considerable number of dormant buds on the older and larger branches. The shoot-axes in healthy trees, especially the terminal ones, generally attain a growth of 6 to 20 inches and develop ten to twenty vigorous leaves with dormant blossom and foliage buds in their axils. As the season advances such shoots ripen their wood, cast their foliage, and remain quiescent until spring invites the opening of their buds and the renewal of vegetative activity. In diseased trees, the shoot-axes push only 1 to 3 inches, lose, almost completely, the ability to develop and ripen wood, and to form dormant buds. The buds on such shoots grow as soon as they are formed, or rather, as soon as they receive the initial differentiation, developing into diminutive soft branches, which frequently branch again, but never attain any good degree of size, vigor, or maturity. It is ordinary to find 15 to 30 primary branches and often some additional secondary ones, on a shoot-axis less than 3 inches long, and not over one-eighth inch in diameter at its base. The tendency of this effort of branching is from below upward, *i e.*, the oldest and largest branches are near the base of the shoot, but almost always not quite from the base, the buds remaining undeveloped in some of the lowest leaf axils.

(*b*) *The foliage.*—The leaves on these dwarfed branching shoot-axes are multiplied correspondingly, and the result is compact tufts or rosettes containing 200 to 400 diminutive leaves, and many additional green stipules which are frequently misshappen and abnormal. The older and larger leaves near the base of the shoot frequently reach a length of several inches and are characterized by a very pronounced inrolling of the margins of the leaf, and by a certain stiffness due to a peculiar straightening of the midrib. These leaves turn yellow in early summer and fall very readily. Jarring causes them to fall by the hundred, as if it were autumn. Very often they are blotched, browned, and dead in places, especially at the ends and margins, from the attacks of various leaf fungi. The younger and central leaves of the rosette remain small and green and free from fungi. They are usually somewhat folded, but seldom rolled. As summer advances these rosettes dry up and die under the attacks of *Scolytus rugulosus* or from the effects of the disease. The foliage of some affected trees is much greener than others. Generally the prevailing color from a distance is yellowish green or olivaceous. The bunching of the leaves is conspicuous and makes the trees noticable at a long distance. There is not enough foliage to give shade or hide the branches.

(*c*) *Flowers and fruits.*—So far as I can determine by inquiry, the trees which developed this disease in 1891 in Mr. Husted's orchards did not blossom in advance of other trees, but were somewhat tardy. On the contrary, other trees in the same orchard, imported from New Jersey and affected with an entirely different disease, and what appears to be genuine yellows, blossomed ten days in advance of the proper time.

Trees attacked by rosette generally drop their fruit early and while it is still green or yellowish green. In June, 1891, I saw scattering fruits on many diseased trees, and none of them were premature or bore any of the characteristic symptoms of peach yellows. The fruit, even on badly affected limbs, when there was any at all, was small, green, or yellowish green, and often more or less shriveled. Fruits of this kind were also common on the ground under such trees. Plate XXXIII shows two peach twigs bearing green fruits; the right-hand figure was from the healthy-looking side of a tree, the left-hand one from twigs just beginning to develop rosettes, and very close to branches bearing thoroughly diseased and very typical rosettes. Its own buds were also pushing into rosettes above the fruit and below. One yellowish green shriveling fruit remained and another had fallen. In one instance the disease was observed in Alexanders which were full of ripening fruit and affected by the rosette only on about one-half of the limbs. Most of the fruit had already fallen from the diseased limbs, green and shriveled, but a few peaches remained on the healthier portions, and these, like those on the other limbs, were neither premature nor red-spotted, but were ripening at the proper time and in the normal manner. The diseased branches bore hundreds of yellowish rosettes; the healthy ones bore an abundance of dark green, handsome foliage.

My search for premature fruit was the more careful because I had ventured the assertion that it would, no doubt, be found to precede the rosette. In one or two instances only, I heard of premature peaches, but on examination they were clearly attributable to borers and not the sort produced by yellows. In one orchard where the borers had been left undisturbed for several years, I saw fruits prematuring on many trees, but there were no symptoms of yellows. The color and flavor of these fruits was natural and they were ripening only a week or ten days in advance of the proper time.

(*d*) *Roots and rootlets.*—Superficially the roots appear to be normal, but the rootlets are dead and shriveled as in peach yellows.

(*e*) *Gummosis.*—The green and shriveling fruits from rosetted limbs were full of minute gum-pockets, but this symptom was afterwards observed quite frequently in imperfect fruits taken from healthy trees. The "June-drop" from Elberta trees was very copious at Griffin, Georgia, in 1891, and most of these fruits were smooth externally but gummy within, the entire seed-cavity being changed into a gum-pocket in many cases. These fruits were an inch by an inch and a half in diameter at time of dropping.

Many of the roots of rosetted trees were honeycombed by gum-pockets (June, 1891). This symptom was found to be nearly constant; *i. e.*, it occurred on some roots of nearly every affected tree. But it was also observed to a slight extent on the roots of two trees which stand very near diseased ones, but which have not yet developed any symptoms of the rosette. Many of the roots were so gummy as to feel sticky when bruised. By making a clean cut at right angles to the main axis of the root the gum-pockets were frequently visible without the aid of a triplet, especially when the oozing of gum was copious. These pockets were confined generally to the outer part of the wood cylinder, and in several cases, known to have been healthy in November, 1890, the cylinder of gum-cavities was confined to the wood laid down in 1891, or to the dividing line between this wood cylinder and the next inner one, and did not extend into the wood formed in 1890.

These closed gum-pockets involve few to many wood fibers, and frequently include the very resistant cells of the medullary rays. On cross-section they appear like an interrupted ring, or like a necklace of triangular beads, in which each member corresponds to a pocket. The base of these triangular cavities was always nearest the pith. Occasionally two cylinders of gum-pockets were observed, one in wood formed early this spring when the disease first appeared in the trees and the other formed in wood recently laid down. In a few cases they occurred also in the bark. The walls were brownish and irregular, with modified and frequently hypertrophied and projecting cells. These cavities appeared to be free from mycelium and bacteria, and cultures from the walls and the exuding gum gave no positive results.

The roots of about fifty trees were examined for this symptom, but lack of time prevented the examinations from being as extensive and complete as desirable.

(3) *First appearance and present distribution.*—So far as I can learn by diligent inquiry this disease first appeared in Georgia about 10 years ago. It may have existed longer, but satisfactory evidence of this is wanting. It occurs in the middle and north part of Georgia quite generally, but I have not observed it in South Georgia or in Florida, nor in South Carolina or States to the north.

This disease, or one very much like it, also occurs in Kansas. It appeared at Manhattan in 1889, and is now quite prevalent in that locality, but has not been reported from other parts of that State.

The disease is very destructive in both States. Mr. T. C. Wells, of Manhattan, Kansas, lost his entire orchard in 2 years. Mr. R. C. Fryer, of Shiloh, Georgia, has lost several orchards, each in a space of about 3 years. In other parts of Georgia the disease has progressed less rapidly, but no less surely. About Griffin, Georgia, the seedling-peach orchards, and the wild plums have suffered most, but the disease has been in the budded orchards for some time, and is gaining ground every year. Next to peach yellows, I regard it as the most dangerous enemy to peach culture in the United States. In some respects it is worse than yellows, because it runs its course more speedily and is more apt to take the entire tree from the start. Should it become as prevalent in Kansas and Georgia as yellows now is in north Maryland and Delaware, profitable peach growing will be entirely out of the question.

II.—INOCULATIONS.

Experiment 1.—One hundred and twenty-five trees were selected for this series of inoculations. They were grown in 1889 by J. D. Husted, Vineyard, Georgia, and formed part of a nursery of several thousand seedlings, which were not budded that year, but were cut to the ground in the spring of 1890, so as to be suitable for budding the following summer. All of them appeared to be healthy and the shoots of the season were vigorous and in good condition for inoculation. The trees selected were the outer five rows in the southeast corner, and were not different in appearance from the rest of the nursery.

The buds for inoculation came from several 5-year old trees in an orchard on the same farm. These trees were badly diseased in all parts, but were vigorous and free from any sign of disease in 1889. They were dug out and burned soon after the buds were taken, but, judging from the rapid progress of the disease in other trees similarly affected, they would not have lived through the growing season. It was impossible to find dormant buds, so I selected the base of such diseased shoots or rosettes as had pushed only a little way, removing from them all of the foliage. They were cut June 21, 1890, and inserted the same day, two into each tree, in the customary way. The inoculation was skillfully performed, and an examination two weeks later showed that nearly all of the buds had healed on satisfactorily and were alive. As in Part I, Experiment 2, the tops of the seedlings were purposely allowed to remain.

Some of these trees began to show signs of disease in August, *i. e.*, within 2 months, but they were not examined until November 3, *i. e.*, 4 months and 12 days from the date of inoculation. Then a careful examination revealed the following conditions: Of the 125 seedlings which were inoculated, 57 were healthy, 66 were diseased, and 2 appeared to be dead.

In 6 of the 57 healthy, one or both of the inserted buds had pushed into diseased growths; in the rest, the buds had made no growth (the majority), or only a slight growth of uncertain character. In most cases the bark inserted with the buds was still living.

Sixty-six of the stocks had the same disease as the trees from which the buds were cut. The diseased shoots pushed out indifferently above or below the inserted buds, or from both places. These stocks might have been grouped into four classes according to the severity of the symptoms: (1) Doubtful, 4; (2) very slight symptoms readily overlooked, 20; (3) worse affected than No. 2, but also not likely to attract casual attention, 36; (4) bad cases which no one could overlook, 6. Five of the latter were photographed, and two are represented on plate XXXIV. Some of these growths were as much as 6 inches from the nearest inserted bud. In 39 of these trees the inserted buds did not grow, or grew only slightly, the bark which was inserted with them being yet alive. In 27, one or both of the buds had grown into diseased shoots. All but 1 of the 6 bad cases fell into the second category. The character of these growths was much like yellows, except that the shoot-axes were greatly reduced, making them much more tufted. The winter buds pushed in the same way—prematurely.

The remainder of this nursery was used for comparison, but a careful examination of many trees brought to light no traces of this disease. The orchards on the same farm might also have served for control. This disease occurs throughout the surrounding country, but is not what might be called epidemic. The farm contains about 100 acres of peach orchard of various ages. The disease first appeared on it in 1887, and the number of cases each year has been as follows: 1887, 2; 1888, 5; 1889, 13; 1890, 31; 1891, 47. This year, in which more cases developed than any previous year, they numbered only about one-third of 1 per cent. In the nearest orchards on other farms the per cent of loss has also been slight.

This experiment attracted some local attention, and the trees which furnished the photographs were shown to many persons at a meeting of the Middle Georgia Horticultural Society, November 6, 1890.

The rapid progress of the disease was surprising. Over one-half of the stocks became affected *in less than 5 months*, whereas results were not expected until 1891, if at all.

These trees were re-examined June 3–6, 1891, at the urgent request of Mr. Husted, who desired to get rid of them. The results surprised and delighted me beyond expectation. The diseased trees were distinguishable at a great distance, and at first glance it looked as though every part of every tree was affected. The actual conditions were as follows:

(1) Four trees were entirely free from disease and had made an excellent growth, their average height being about 4 feet.

(2) Two trees were badly diseased, but a few small branches had developed normal, or nearly normal, leaves and shoot-axes, while a few others bore sickly yellowish leaves and no rosettes. These trees were dwarfed, and at least nineteen-twentieths of the branches bore yellowish green rosettes.

(3) The remaining trees, 113 in number, were diseased in all parts, exactly as had been the trees from which the buds were taken. The leaves and shoot-axes were stunted, yellowish green, and bunched into striking rosettes. Out of this large number of trees there was not one which bore a single healthy leaf or a normally-developed shoot-axis. Every part of each tree was completely diseased. The greater number were still alive in all parts, but a few were withering (see left-hand figure of plate XXXV), and a few were already dead. Almost all of the winter buds developed into rosettes in spring, and in some cases these appeared also on the stems above and below the location of the inserted buds (plate XXXV).

A more satisfactory outcome could scarcely be desired for any experiment whatsoever.

Each tree was carefully examined, and notes were made on the condition of each inserted bud. These observations were also verified, at my request, by Mr. W. T. Swingle, of the Division of Vegetable Pathology, so as to leave no doubt whatever concerning their value.

In the four trees which remained healthy the inserted buds failed to unite with the stocks and were thrown off, the bark of the stock having healed over under them. The only uncertainty was concerning a small fragment of the bark of one bud, and the evidence of union in this case was so unsatisfactory that it was entered as "very doubtful." Three of these trees received two buds each, but by accident the other received only one bud.

In one of the 115 diseased trees the evidence of union between the stock and the two inserted buds was also doubtful. In all of the others some part of one or both buds had united with the stock, and in many instances was still living. This was also true of the 6 trees removed in 1890. Often, however, only small fragments of each bud healed on. Occasionally less than one-fourth of 1 square centimetre of the bark of one bud was all of the diseased tissue that had actually united with the stock, and yet this was sufficient to induce the disease. None of the inserted buds pushed over 3 inches, most failed entirely or pushed only one-fourth inch to 1 inch and then died.

The diseased seedlings were noticeably smaller than the four healthy ones. On an average they were about 3 feet high with a proportionate spread of branches.

The contrast between the November and June examinations is noteworthy. In November, when the disease had been acting less than 5 months, only 66 of the stocks showed any symptoms whatever. None of them were wholly diseased; most showed no signs of disease at a distance, and even a large part of the six worst cases was still free from symptoms (plate XXXIV). In June, after the disease had been acting nearly a year, 121 of the original 125 trees had become affected, and 115 so completely that it was almost impossible to find any healthy branches. The only uncertainty is concerning the six which were removed in November for photographic purposes. Their condition, however, at that time (plate XXXIV) warrants one in believing that they too would have become wholly diseased long before June.

This experiment was the more striking, because in the same field, forming part of the same nursery, and separated from these five rows only by the width of a one-horse cultivator, are about 4,000 Elberta trees, which were budded on the same stocks and at about the same date with buds cut from healthy trees on the same farm. These trees were carefully examined for the rosette, but in the whole nursery there was not one case, nor even one suspicious tree. The line of separation between these healthy trees and the five inoculated rows was sharp as could be desired, and the contrast was most astonishing (plate XXXVIII). Two of these Elberta trees are also contrasted on plate XXXVII with two inoculated and diseased trees from the adjoining row, only about 2½ feet distant.

Plate XXXVI contrasts one of the inoculated and diseased seedlings with one of the four which failed to take the disease. Plate XXXV shows part of one inoculated row with rosettes on some of the stems as well as on all of the terminal growth. The foliage on the left-hand tree had already begun to wilt and shrivel. Plate XXXVIII gives a birds-eye view of the field, contrasting some of the inoculated diseased trees with the neighboring healthy Elbertas.

Naturally, the results of this experiment attracted considerable attention in Georgia, especially the appearance in the spring and summer of 1891. The trees were examined by many persons, including Col. R. J. Redding, director of the Georgia Experiment Station; Gustave Speth, Horticulturist of the Georgia Experiment Station; Prof. J. E. Willet, of Macon; H. W. Hasselkus, of Griffin, and Rudolph Œtter, of Vineyard. A summary of the final results was given before a meeting of the Middle Georgia Horticultural Society June 9, 1891. The matter was also brought to the attention of Mr. Berckmans and other members of the State Horticultural Society.

Experiment 2.—This was also performed at Vineyard, Georgia, on the farm of J. D. Husted.

The 56 trees selected for this series of inoculations were vigorous, well-rooted cuttings of the Mariana plum. They formed part of a small nursery grown in 1889, but not budded that year, being cut to the ground in the spring of 1890, so as to secure fresh shoots for budding the following summer. These trees formed the east end of the south row and were not different in appearance from the rest. All were the picture of health.

The buds for inoculation were taken from the north side of a seedling peach tree which was growing by the wayside near Pomona, Georgia. This tree may have been 4 years old. The south one-half of it was diseased by the rosette, and the remainder appeared to be healthy. Well-matured *terminal shoots* from the healthy-looking branches were selected for use in budding. All of them bore full-grown leaves of a healthy green, and their buds showed no tendency to germinate. Moreover, all of the foliage on the branches in the immediate vicinity was full grown and healthy, and there were no signs of disease nearer than the base of the main branches, 4 to 6 feet below. The buds were cut July 1, 1890, and inserted the same day—two into each tree—in the usual way. A subsequent examination showed that many of them had healed on and were living. The tops of the cuttings were not removed until some weeks later.

These trees were reëxamined November 3, 1890. At that time only 32 of the 56 stocks bore peach shoots. Upon the rest the buds failed to take or died soon after commencing to grow. In 30 of the stocks the buds had grown into shoots, which were 15 to 30 inches long. In many cases both buds grew. The foliage, which had not yet fallen, was normal, except for slight parasitism of *Puccinia pruni*, Pers., and the shoots were vigorous. There were no rosettes, no winter buds were germinating, nor were there any other signs of the disease. One bud only developed in each of the other two. One had grown only about 8 inches, but was normal; the other had grown only ½ inch and the foliage was reddish and unhealthy. All of the stocks appeared to be as healthy as when the buds were inserted.

The parent tree was also examined at this time. The disease had made considerable progress, but careful search failed to discover any germinating buds or sickly shoots upon that part of the tree which supplied the buds for inoculation. There were signs of disease at the union of the main limb and the stem, but none further up. All large parts of the tree were still alive.

This tree was reëxamined June 8, 1891. It bore no normal leaves or shoot-axes. The limbs which were first to manifest disease in 1890 were now dead in great part, and all other portions of the tree were badly diseased, including the branches from which the buds were taken. Unfortunately the extreme ends of the branches were dead without symptoms of rosette or foliage of any sort, but they were living last November and are now alive to within 1 foot of the cuts, and bear very sickly rosettes.

The peach tops inoculated upon the Mariana plums were again examined June 22, 1891, and the contrast between them and the condition of the tree which furnished the buds was very great. They looked as healthy and vigorous as did the north side of the parent tree when the buds were cut.

Fifteen stocks bore double shoots and 16 bore single shoots, making a total of 46 living peach shoots on 31 stocks. A very few of the remaining Mariana stocks died; the rest grew thriftily and were cut back to the earth at the time of this examination. None developed any symptoms of rosette. The average growth of the peach shoots to date is 3 to 3½ feet, and their diameter at the base where they join the plum is ⅜ to $\frac{6}{8}$ inch. They show no symptoms of rosette or decline, while the parent tree is now affected in all parts and already half dead.

In another way this experiment establishes the same fact as No. 1, *i. e.*, *the gradual transmission* of a germ or virus of some sort from diseased to healthy parts. Clearly something is now affecting the tissues of the north part of the parent tree which was not in them one year ago. Otherwise the 46 peach shoots should now be diseased exactly like that part of the parent tree.

It is obvious that some years must elapse before this experiment is complete, but enough has been observed already to make it almost certain that the disease was not communicated by these buds. It is the same kind of an experiment as No. 4 of Part I.

III.—CONCLUSIONS.

(1) The rosette, as now understood, differs from peach yellows in the following particulars:

(*a*) The more tufted character and somewhat different appearance of the diseased growths.

(*b*) The much greater tendency of these compactly tufted growths to develop in early spring from winter buds and to appear all over the tree.

(*c*) A less tendency to develop sprouts upon the trunk and main limbs.

(*d*) The absence of premature fruit.

(*e*) The general early fall of leaves and fruit on affected trees, the fruit being small, yellowish green, and more or less shriveled and gummy.

(*f*) Gummosis of the roots.

(*g*) The occurrence of the disease in plums.

(*h*) The much more speedy destruction of affected trees.

(2) The disease is virulently contagious (Experiment 1), and it is probable that something might be done toward checking its increase by the prompt destruction of all affected trees. This should be done in early spring, as soon as the disease appears and before the leaves begin to fall.

(3) The disease may exist for a short time in part of a tree without being in the rest of it (Experiment 2), but it soon involves the entire tree. In other words, it would seem from Experiment 2 that the cause of the disease must enter the tree at some particular point or points and be carried gradually to all parts through the circulation. A comparison of the November and June examinations in Experiment 1 also confirms this belief.

(4) As in peach yellows, the admitted fact that neighboring trees are not always the next to take the disease is no argument against its communicable nature.

(5) This disease has gained a strong foothold and is on the increase, especially in that part of Georgia known geologically as the Archæan.

(6) If Georgia peach-growers would save their orchards and maintain the successful cultivation of the peach, the necessity for prompt and concerted action appears to be very great.

EXPLANATION OF PLATES.

I.—PEACH YELLOWS.

I. Fig. 1, healthy fruit of Stump the World or Old Mixon, nearly full grown, but still green; Fig. 2, prematurely ripe, red-spotted peach of the same variety, picked the same day from a neighboring tree, affected by yellows. Photo. August 20, 1888, Dover, Del. Natural size.

II. Growth from the trunk of a diseased tree, showing premature unfolding of winter buds. Photo. December 4. 1890. Upper orchard on the grounds of the State agricultural college, Amherst, Mass.

III. Fig. 1, represents three shoots taken from the main limbs of a diseased tree in the autumn of 1890. The spring foliage has fallen almost completely, and what remains has developed unnaturally from winter buds. Fig. 2, represents a healthy shoot taken from the trunk of a neighboring tree. The droop of the foliage is due to loss of water after the shoot was pulled and before it could be photograped. Photo. October, 1890, Still Pond, Md.

IV. Terminal shoots taken from diseased trees in the autumn of 1890. In Figs. 1, 2, and 3, the spring foliage has fallen almost completely, and what remains has developed unnaturally from winter buds. In Fig. 4 some of the spring foliage remains. In Figs. 2 and 4 the disease has induced the autumn development of blossoms. Photo. October 15, 1890, Still Pond, Md.

V. Terminal spring growths from a tree at South Haven, Mich. Branches very compactly tufted for yellows, and somewhat approaching the Rosette, but believed to be distinct. Foliage removed from one tuft to show manner of branching. All above *X* is the growth of one season. Reduced to one-half natural size. Photo. July 23, 1889.

VI. Terminal summer and autumn growths from trees in Delaware. Fig. 1 is more advanced than Fig. 2. All shoots above *X* and x′ are the growth of one season. In each very little spring foliage remains. This is the common appearance of the disease. Photo. Fig. 1, September 27, 1887; Fig. 2, September 27, 1890; Dover, Del. About one eighth natural size.

VII*a*. A tree in the last stage of yellows. Diseased for several years. Smyrna, Del. Photo. July 21, 1891. Orchard No. 8 of First Report.

VII*b*. Represents a tree killed by yellows in 3½ years' time, and shows branched character of the last feeble growths. The entire corner was full of thrifty trees, but they are now badly diseased, and the orchard has been allowed to grow up to grass and weeds. Formerly it was very carefully tilled. Tree became affected in the spring of 1887 and died in the summer of 1890. Photo. September 30, 1890, Magnolia, Del.

INOCULATION EXPERIMENT NO. 1.

VIII. First results, year 1888. Three figures showing unusual number of sprouts and the unfolding of the winter buds in autumn. Fig. 1, *a* and *a′* are the inserted buds; *a* failed to grow but, *a′* grew into a vigorous shoot, on which all the winter buds pushed; *bbb* are diseased growths from the stock. Fig. 2, *a* and *a′* represent growths from the inserted buds. The lower shoots are diseased growths from the stock. Fig. 3, *a* and *a′* represent the inserted buds; *a* failed to grow, but *a′* grew into a branching diseased shoot, which was cut away; *b*, *b′*, and *b″* are diseased growths from the stock, most of *b* having been cut away. All the foliage is from winter buds. Time, 14 months from date of inoculation. Photos. November 3, 1888.

IX. Year 1889. This plate represents a row of peach trees on the Department grounds. Figs. 1 and 12 are healthy seedling trees, grown from pits, which germinated in the spring of 1888. All the rest are trees 1 year older, but very badly dwarfed and diseased by yellows. Time, 26 months from date of inoculation. These are the ten trees mentioned in the text, and some of them are the ones which furnished the photographs for Plate VIII. They were carefully transplanted in the autumn of 1888 and suffered no injury. Nos. 2, 3, 7, 10, and 11 were already dead at the time this photograph was made. The difference in size is attributable to the dwarfing effects of the disease produced by the inserted buds. The diseased growths in 4, 6, and 9 are principally from the inserted buds; those in 5 and 8 are almost altogether from the seedling stock. Photo. October 21, 1889.

X. Two trees from same row as Plate IX but enlarged to show certain details of the disease. These are Nos. 8 and 9. Much of the foliage is from winter buds, which unfolded in summer and autumn.

XI. Year 1890. Contrast of diseased and healthy trees. Same as Plate IX, but 13 months later, *i. e.*, 3 years and 3 months from inoculation; 1 and 12 are still entirely healthy. They have continued to grow, and have shed their foliage for winter. Nos. 4, 5, 6, and 9 are all that remain of the 10 trees moved and also all that remain of the entire 202 inoculated trees; No. 4 is dead, and 5, 6, and 9 are badly diseased in all parts. All the foliage is from winter buds which developed in autumn, Photographed November 21, 1890. These three trees have proved very resistent and are all alive (August 16, 1891), *i. e.*, 4 full years from date of inoculation.

XII. Part of same row as Plate XI, showing three of the inoculated and diseased trees more in detail (Nos. 4, 5 and 6), also a few branches of No. 1. Photo. November 21, 1890.

INOCULATION EXPERIMENT NO. 2.

XIII. Year 1889. Two figures showing seedling trees completely diseased; *x* indicates the location of the inserted buds which are now dead. Trees, 27 months old. Diseased buds inserted August 3, 1887, *i. e.*, 23 months prior to date of photograph. Photos. July 1, 1889, Hubbardston, Mich.

XIV. Year 1889. Same series as XIII. In Fig. 1 the inserted bud was on the opposite side of the camera and was dead. In Fig. 2, *x* grew from the inserted bud in 1888 but died in 1889. Both trees bore yellowish foliage and were diseased in all parts. The living shoots on the trunks are not from inserted buds. Photos. July 1, 1889, Hubbardston, Mich.

XV. Year 1889. Same series as XIII and XIV. All parts of both trees diseased. In Fig. 1 the healthy-looking part of the tree is the shoot which grew from the inserted bud. In Fig. 2 the inserted bud was dead. Time, 23 months from date of inoculation. Photos. July 1, 1889, Hubbardston, Mich. The trees represented on these three plates were grown by Thos. J. Shallcross, Locust Grove, Md., in 1887. They were budded August 3, 1887; were moved in the spring of 1888 to Michigan, and set at Hubbardston on April 24 of that year. They showed no symptoms of disease until after July, 1888.

XVI, XVII. Year 1889. Healthy unbudded trees for comparison with those shown on Plates XIII to XV. Trees of same age, *i. e.*, 27 months, from same nursery, removed at same time, and set in same field. Reduction the same. Photos. July 1, 1889, Hubbardston, Mich.

XVIII. Year 1890. From same series as XIII to XV, but 13 months later. Trees diseased by yellows in all parts and very sickly. Fig. 1 shows the best one of the 210 inoculated trees. Fig. 2 nearly dead. Time 3 years from inoculation. Trees 41 months old. Photos. July 30, 1890, Hubbardston, Mich.

XIX–XXI. Year 1890. Plates showing effect of inoculations on seven previously healthy trees. Different stages of the disease. Time 3 years. Some entirely dead and others nearly so. Fig. 1, Plate XIX, shows two of a row of healthy trees in the background. The very characteristic branching shoot on the base of Fig. 2, Plate XXI, did not grow from the inserted bud *x* but from the seedling stock some distance above it. Photos. July 30, 1890, Hubbardston, Mich.

XXII. Year 1890. Forty trees killed by yellows in less than 3 years from date of inoculation. Pulled and photographed in one group. July 31, 1890, Hubbardston, Mich. Some died in the fall of 1889, others in the following winter, and the small remainder in the spring of 1890.

XXIII, XXIV. Year 1890. Two unbudded healthy trees of same age for comparison with Plates XVIII to XXII. These figures represent average specimens of all now living (86) of the whole lot set for comparison. Some were larger than those here shown and others a little smaller. These trees were 3 years old from the seed when photographed and have had only ordinary treatment. Photos. July 29, 1890, Hubbardston, Mich.

INOCULATION EXPERIMENT No. 4.

XXV. Year 1890. Barnard tree inoculated in the fall of 1887 from a terminal shoot on the healthy looking side of a diseased tree. Possible long period of incubation. The top here shown was derived from the inserted bud. Photo. January 28, 1891, Delaware.

INOCULATION EXPERIMENT No. 5.

XXVI. Year 1890. Two seedling trees. In Fig. 1 the growth from the inserted bud was about 10 inches long, and more than one-half of its winter buds had unfolded into feeble sprouts. Photo. October 30, 1890. In Fig. 2 the spring foliage had fallen, but the same symptoms were manifest. Photo. December 13, 1890, Washington, D. C.

IMMUNITY.

XXVII. Peach on plum. Trees budded on Mariana stock in August, 1888, set November 7, 1889. Photos. October 18, 1890, Still Pond, Md. Fig. 1, healthy and very thrifty. The white spot on the trunk indicates the point of union between the plum stock and the peach top. Fig. 2, tree badly stunted with yellowish and reddish foliage, but no symptoms of yellows. The peach top had overgrown the plum stock and there was a noticeable swelling just above the point of union.

XXVIII. Resisting power of old trees. Budded peach tree, 36 years old, farm of James S. Harris, Still Pond, Md. The limb marked *x* developed symptoms of yellows in 1890. This tree has stood in a region of diseased orchards for many years, but it was somewhat isolated and well along in years before the disease appeared. Photo. October 18, 1890. The distance marked off on the trunk is 5 feet.

II.—PEACH ROSETTE.

XXIX. Fig. 1, budded peach tree, 5 years old, and diseased in all parts by the rosette. This tree was healthy in 1890. It first manifested symptoms of disease in the spring of 1891, and at the time it was photographed did not bear one healthy or full size leaf or normal shoot axis. Such trees generally die in the summer or autumn of the same year; Fig. 2, healthy budded tree of same age from the same orchard. It might have been only 20 feet distant. Photos. June 3, 1891, Griffin, Ga. Trees about 14 feet high. Part of the left side of each photo is omitted to bring it within the requirements of the plate.

XXX. Terminal branches from a budded tree of bearing age. Fig. 1, still perfectly healthy to all outward appearances. Fig. 2, in first stages of the rosette; Fig. 3, complete, typical rosette. All from the same tree. Reduced to about one-seventh natural size. Photos. July 5, 1890, Griffin, Ga.

XXXI, XXXII. Shoots from a seedling tree of bearing age showing progressive stages of the rosette from appearance of perfect health to complete disease. Fig. 1., perfectly healthy and very thrifty. Foliage smooth and green. Fig. 2, leaves commencing to roll, straighten, and become yellowish; Fig. 3, spring foliage worse diseased than in Fig. 2, and yellowish, rolled, and somewhat injured on the margin by leaf fungi. The winter buds on the upper part of the shoots are unfolding into rosettes. Fig. 4, rosettes developing and fully developed. Photos. July 2, 1890. Tree found in a thicket at Sunny Side, Ga. Reduced to about one-fourth natural size.

XXXIII. Fruit from diseased and healthy looking side of an affected tree. Fig. 1 from a badly rosetted branch. The foliage of this twig was yellowish, and its buds had begun to push into rosettes both above and below the fruit, which was yellowish green and had begun to shrivel slightly but was not strikingly different from Fig. 2. Fig. 2 healthy twig and green, half-grown fruits from same tree. Photo. June, 23, 1891, Griffin, Ga.

INOCULATION EXPERIMENT No. 1.

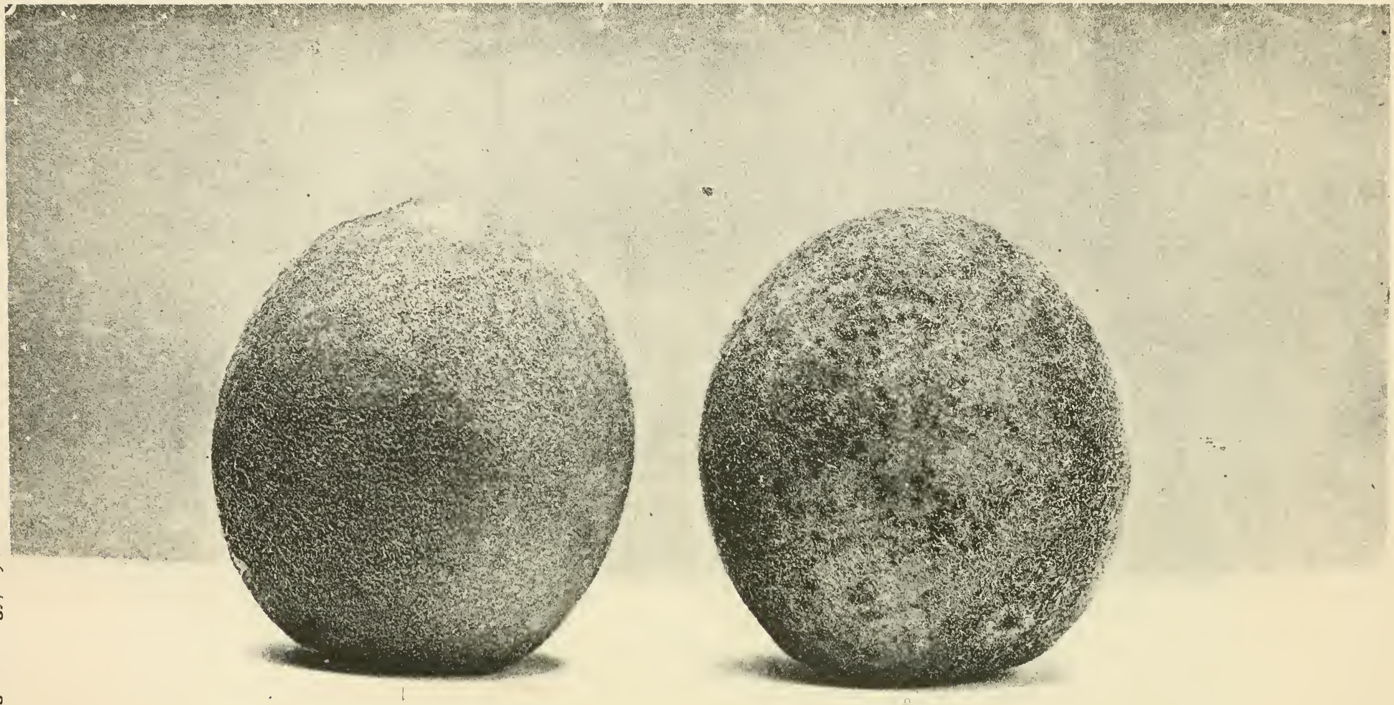
XXXIV. First results, year 1890. Two of the worst affected trees. Time, 4 months and 12 days from date of insertion of the diseased buds. In both figures the bits of white paper indicate the location of these buds. In Fig. 1 both buds united with the stocks, but neither one pushed, the nearest diseased shoot being from the stock. In Fig. 2 the lower bud grew into *x*, while the upper bud did not push. In Fig. 2 the base of the uppermost diseased shoot was 5 inches above the uppermost inserted bud. The left side of each tree appeared to be perfectly healthy. Inoculations June 21, 1890. Photo. November 3, 1890, Griffin, Ga.

XXXV. Year 1891. Row of seedling trees inoculated June 21, 1890. Photo. June 6, 1891, Griffin, Ga. All diseased throughout and left one drying up. The diseased buds were inserted near the earth and the seedling tops were not removed.

XXXVI. Year 1891. Trees inoculated June 21, 1890. Fig. 1, healthy seedling, two buds were inserted, but failed to heal on. Fig. 2, seedling diseased in all parts; one or both of the buds healed on. Photo. June 6, 1891, Griffin, Ga.

XXXVII. Year 1891. Fig. 1, several trees inoculated June 21, 1890, and now diseased in all parts; Fig. 2, two healthy seedlings inoculated with healthy Elberta buds about the same date. Photo. June 6, 1891, Griffin, Ga.

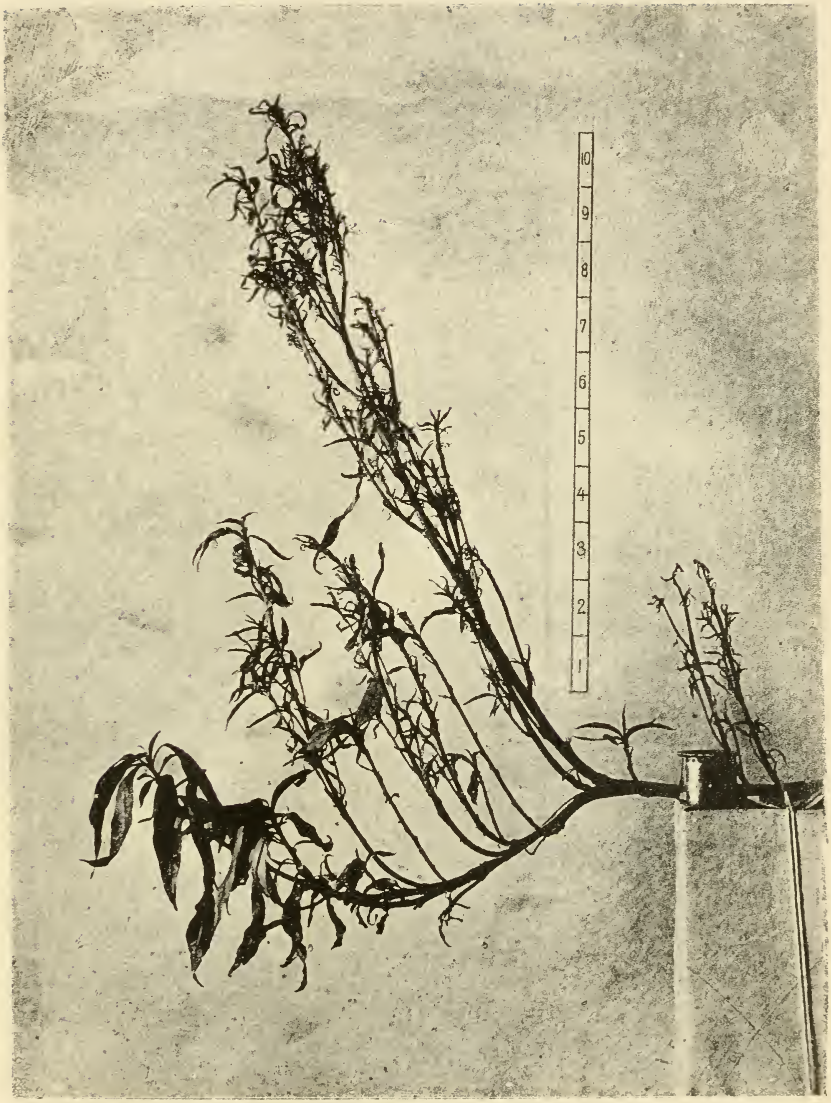
XXXVIII. Year 1891. Result of inoculations. Part I bird's-eye view of rows of seedlings diseased by the rosette as the result of inoculations made June 21, 1890. Part II bird's-eye view of adjoining healthy nursery of Elberta. Photos. June 6, 1891, Griffin, Ga.



PEACH YELLOWS.

Fig. 1. Healthy fruit. Fig. 2. Red spotted and premature fruit.

Dover, Del.



Yellows—Autumn Growth from Winter Buds.

Amherst, Mass.

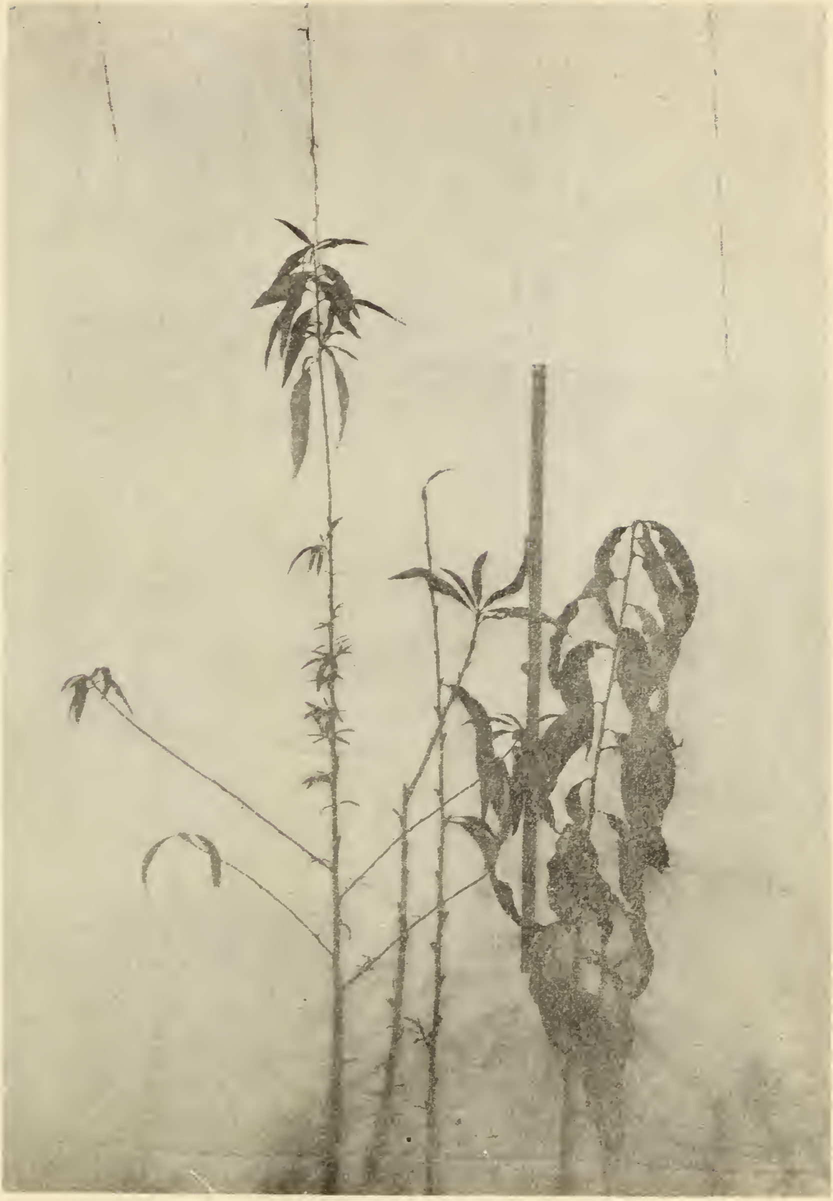
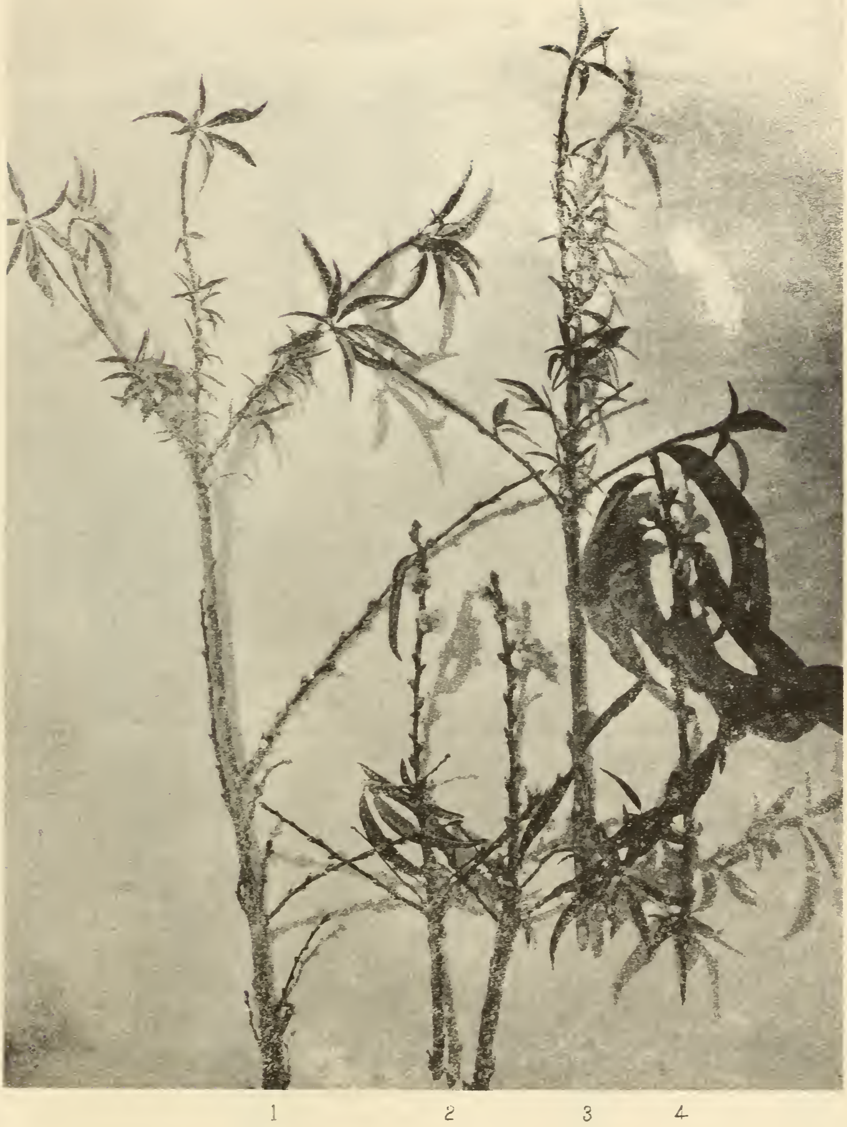


Fig. 1. Fig. 2.

PEACH SHOOTS.

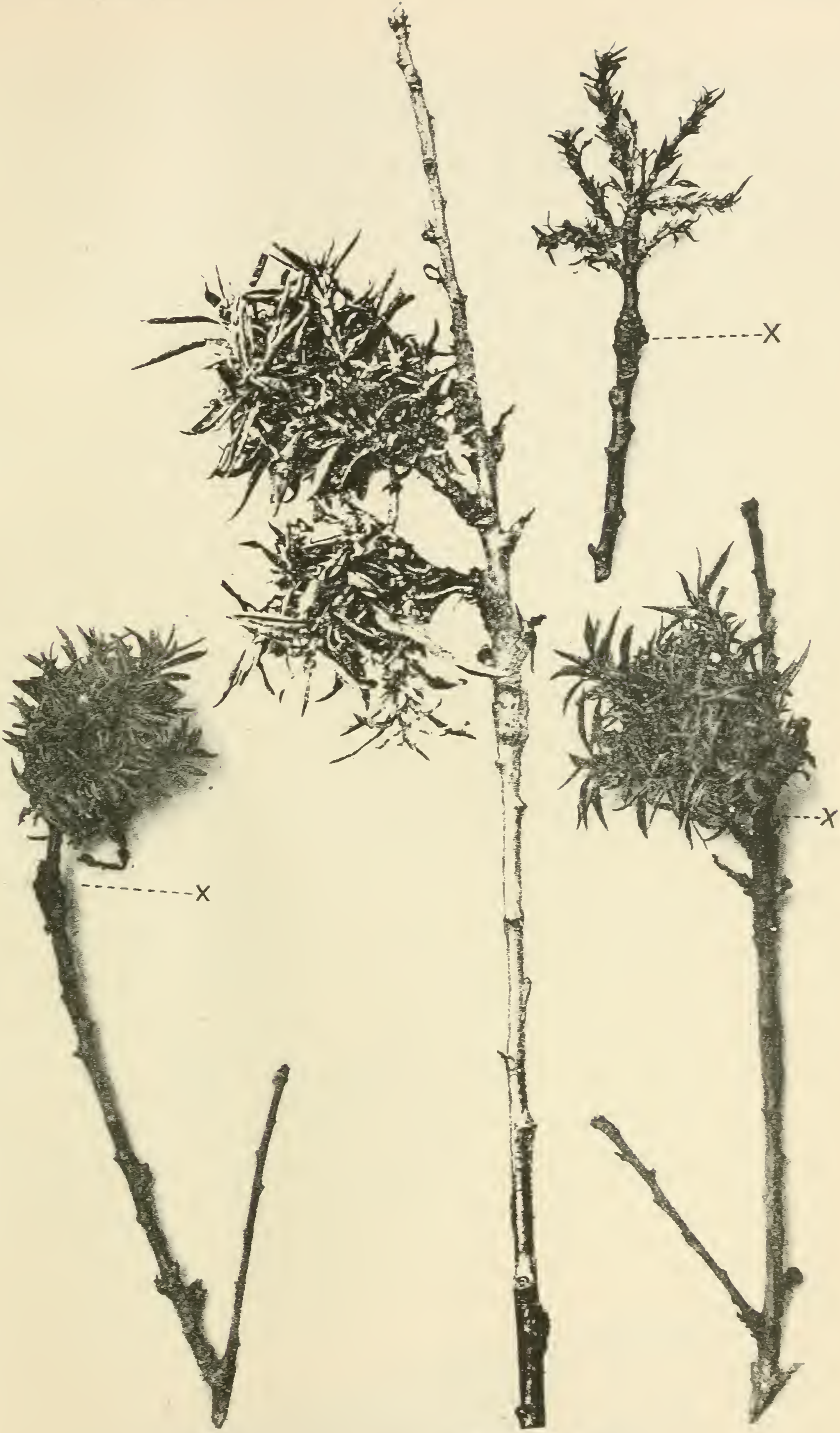
1. Diseased by yellows. 2. Healthy.

Still Pond, Md.



YELLOWS—AUTUMN GROWTHS FROM WINTER BUDS.

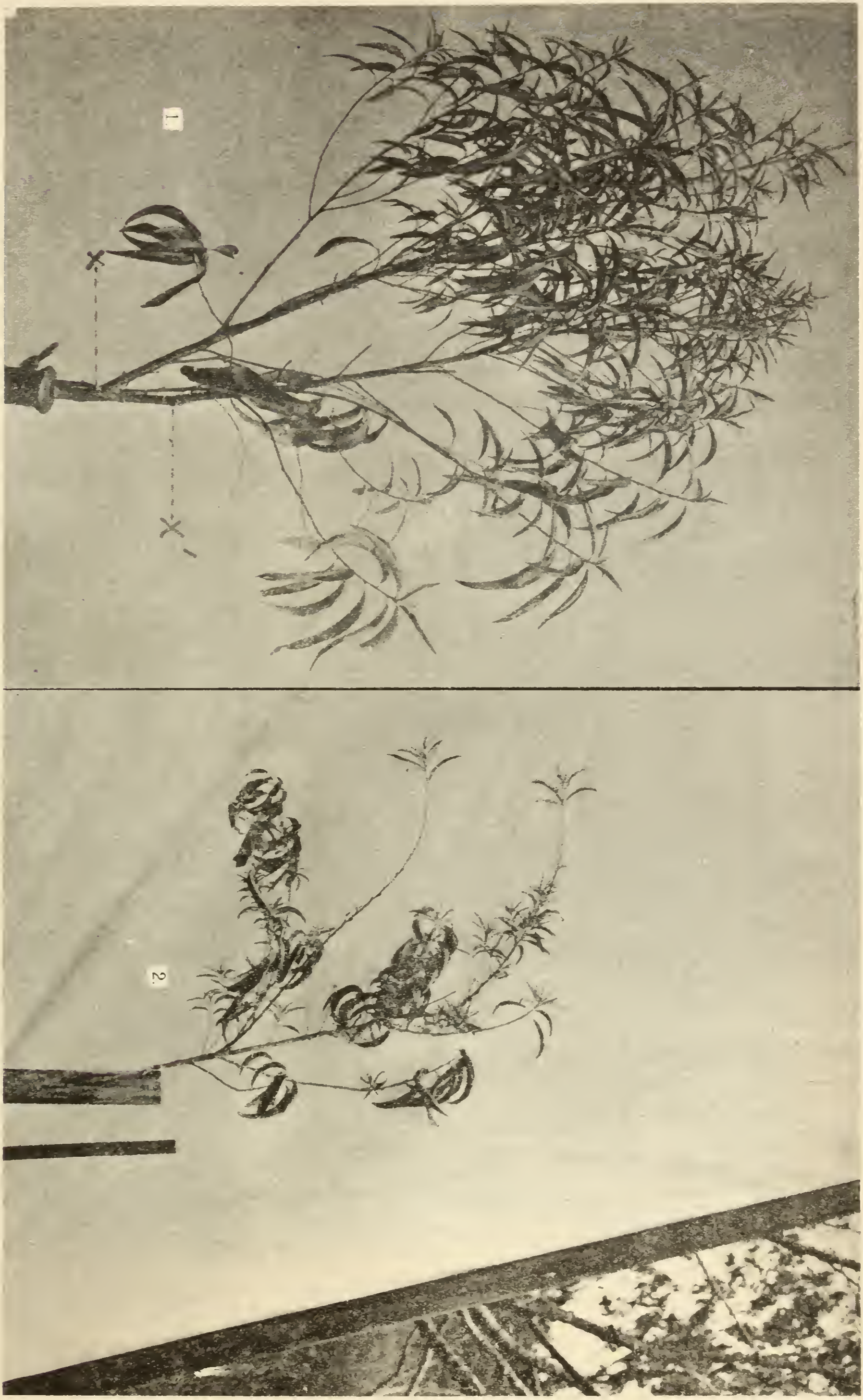
Still Pond, Md.



Yellows—Spring and Summer Growths.

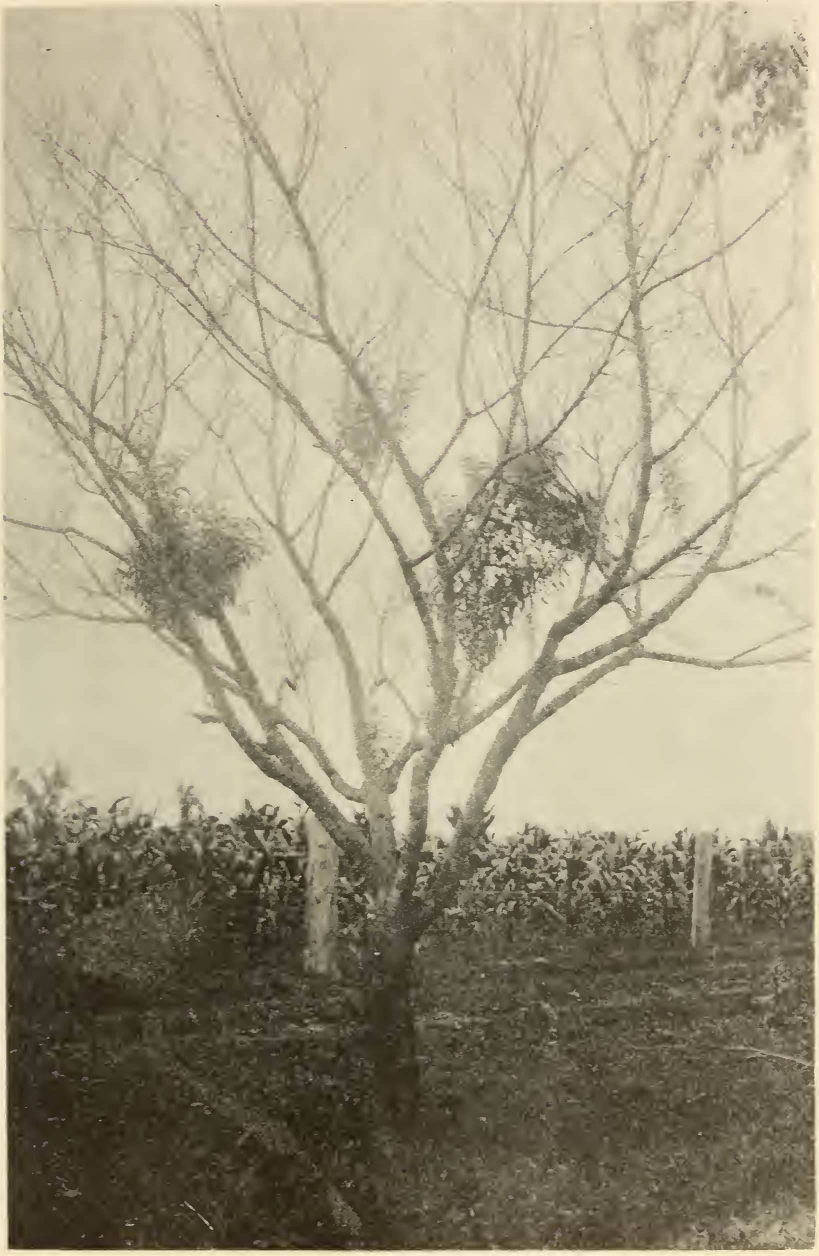
Very unusually tufted.

South Haven, Mich.



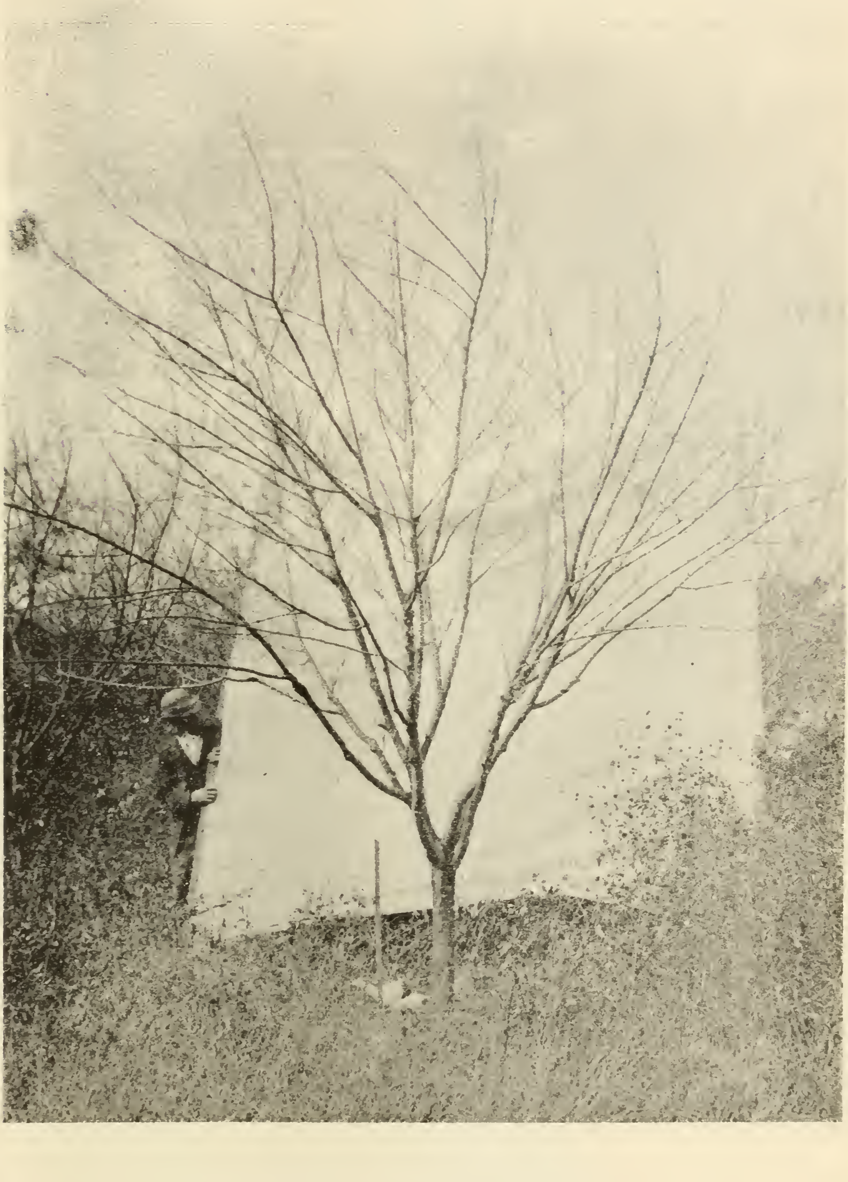
YELLOWS—SUMMER AND AUTUMN GROWTHS FROM WINTER BUDS.

Dover, Del.



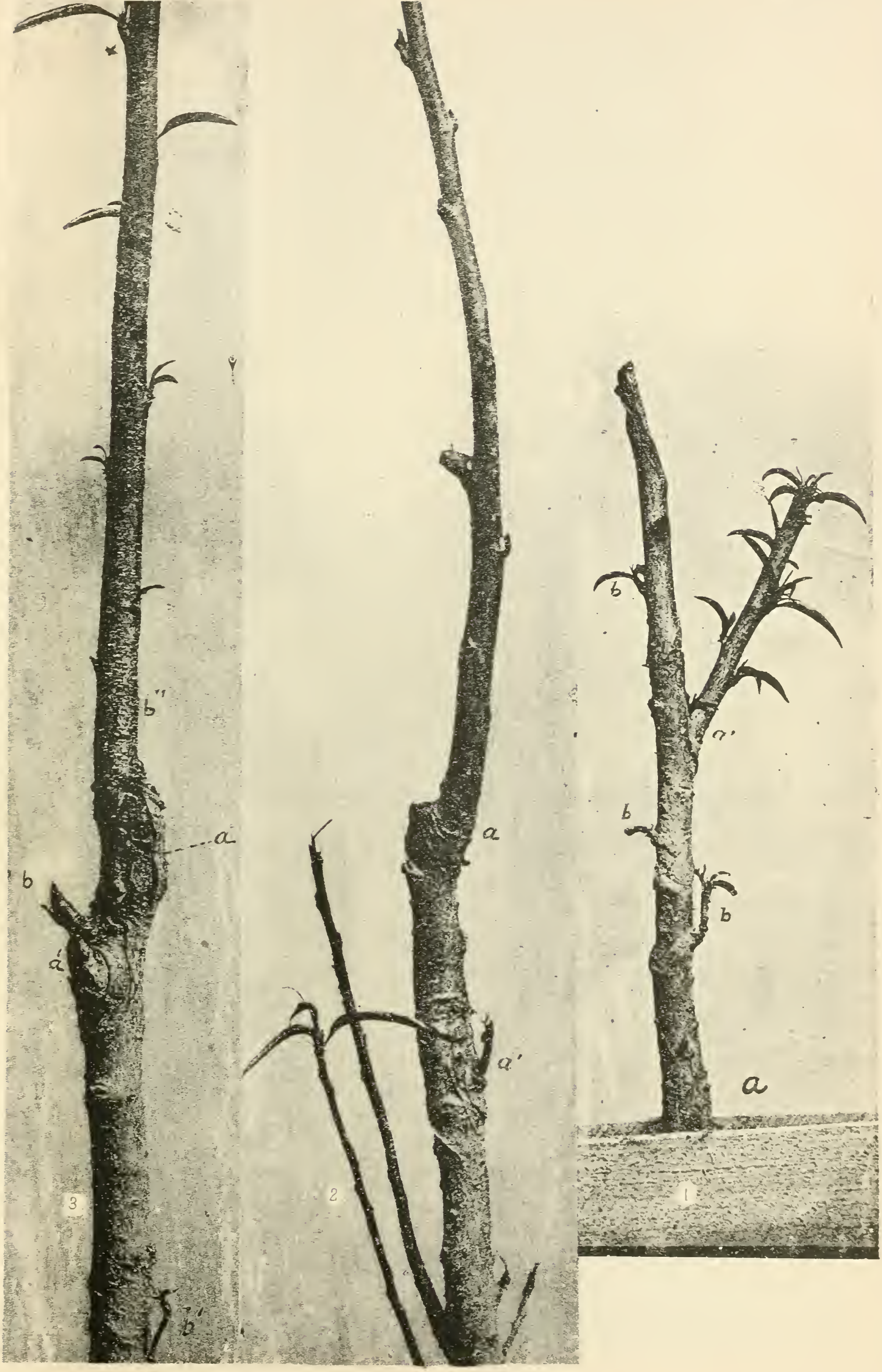
YELLOWS—THE LAST STAGE.

Smyrna, De



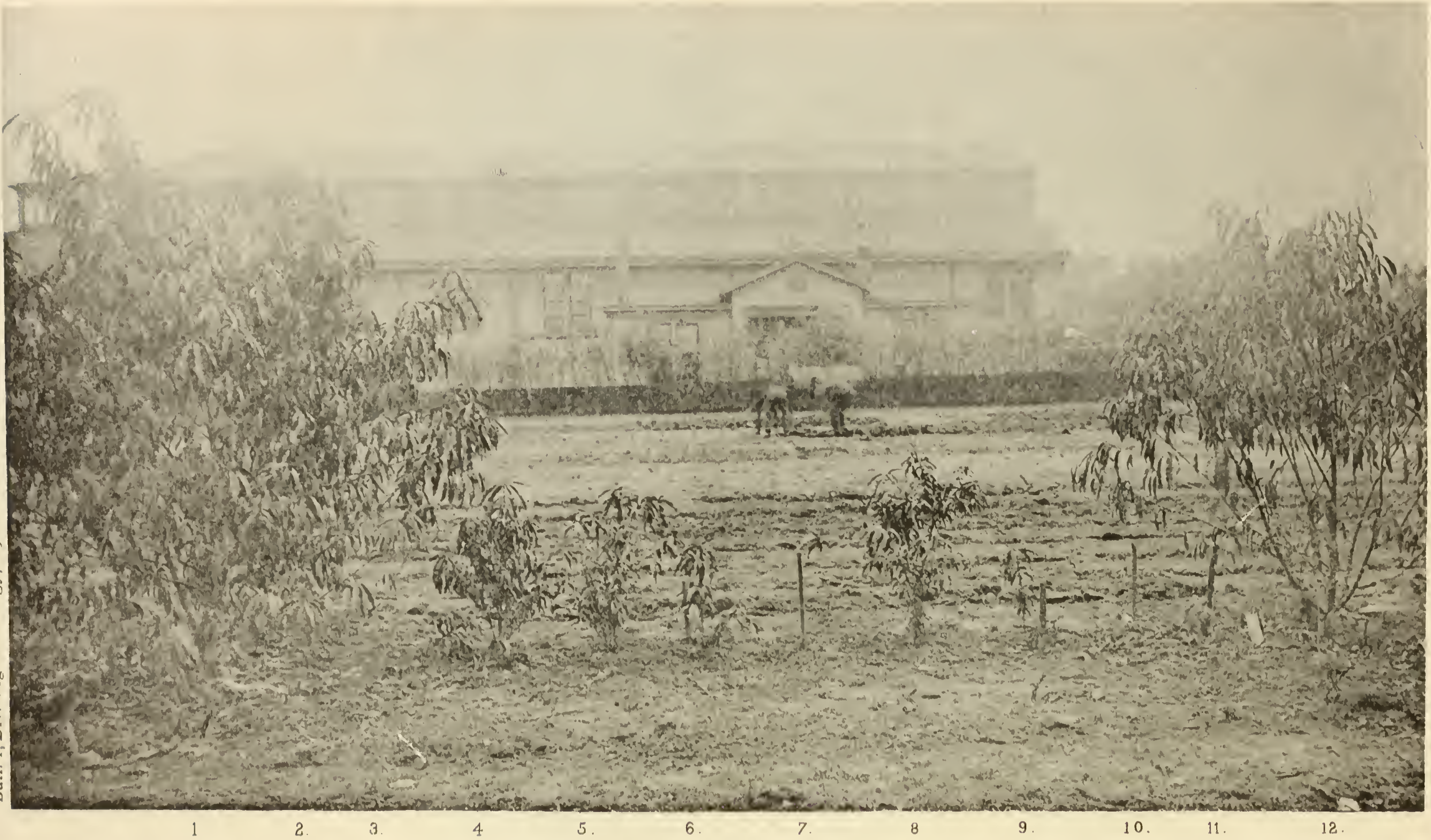
YELLOWS--TREE KILLED IN 3½ YEARS.

Magnolia, Del.



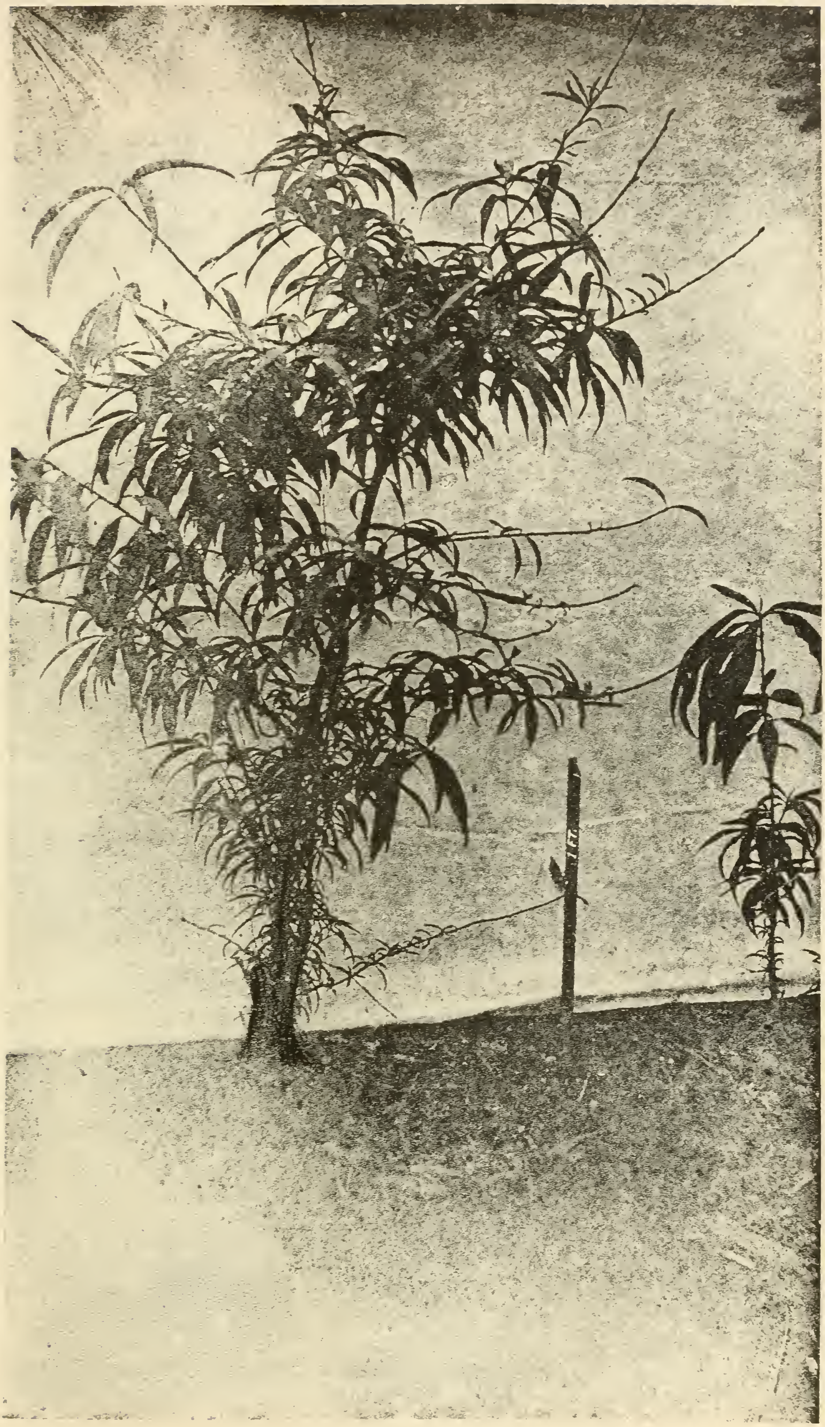
YELLOWS—RESULT OF INOCULATIONS.

Experiment 1, year 1888.



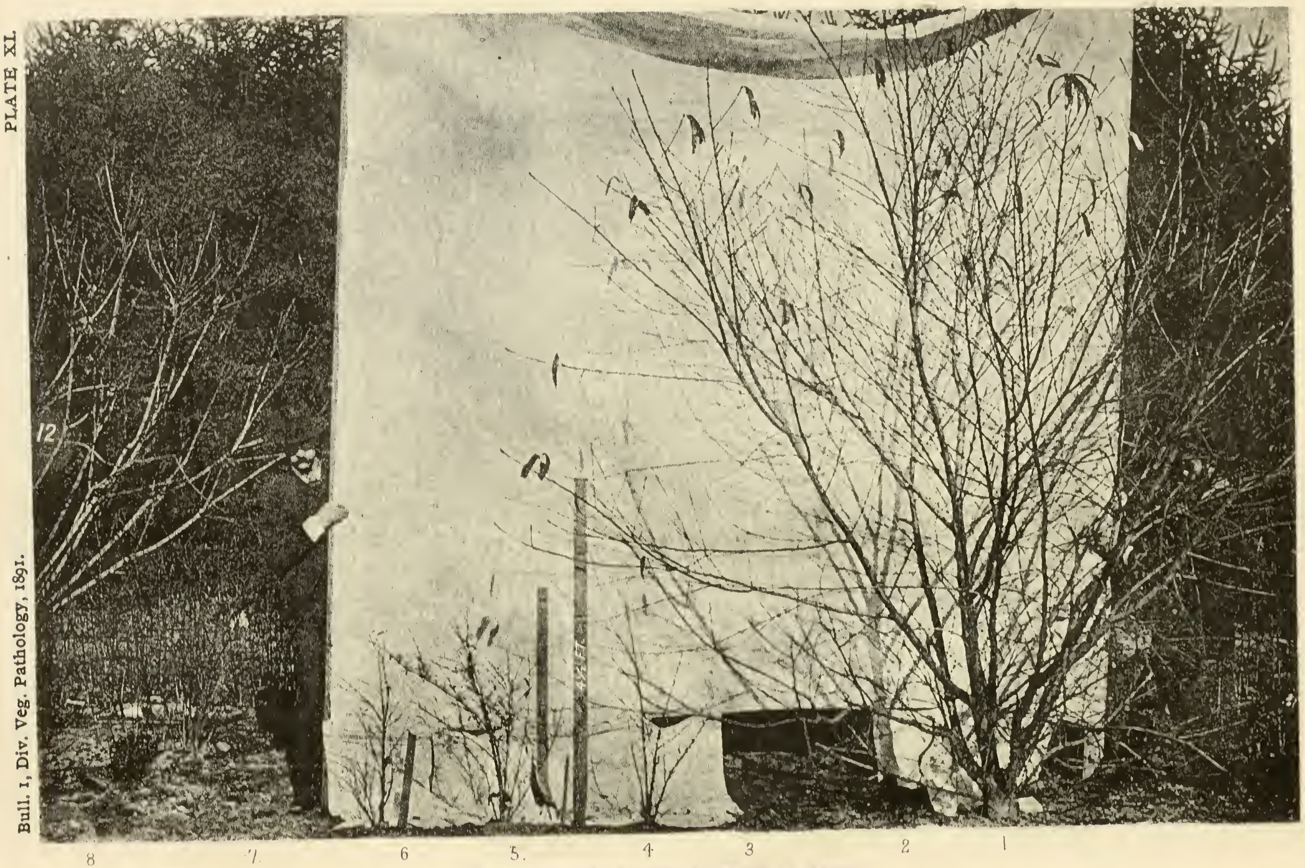
YELLOWS—RESULT OF INOCULATIONS.

Experiment 1, year 1889.



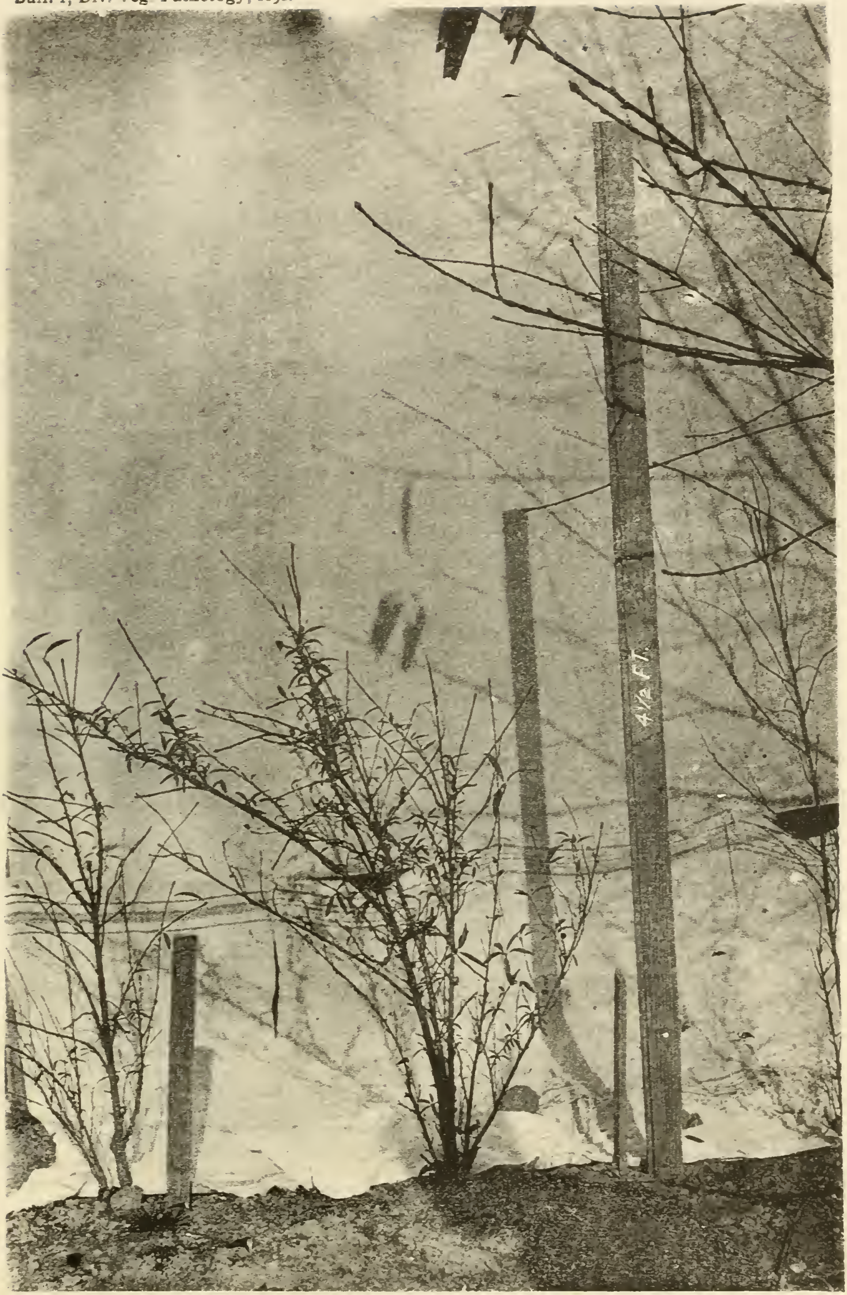
YELLOWS—RESULT OF INOCULATIONS.

Experiment 1, year 1889.



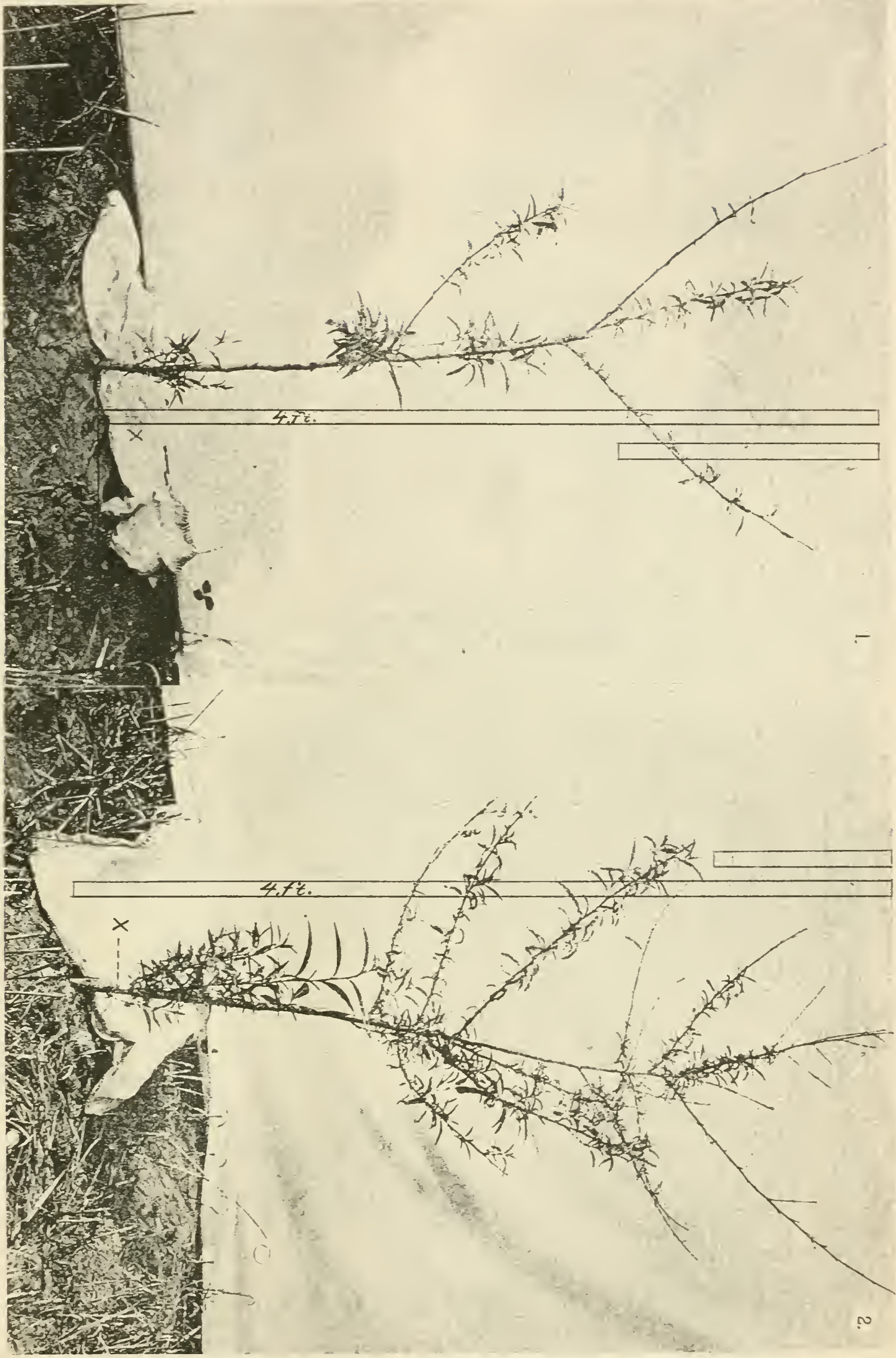
YELLOWS—RESULT OF INOCULATIONS.

Experiment 1, year 1890.



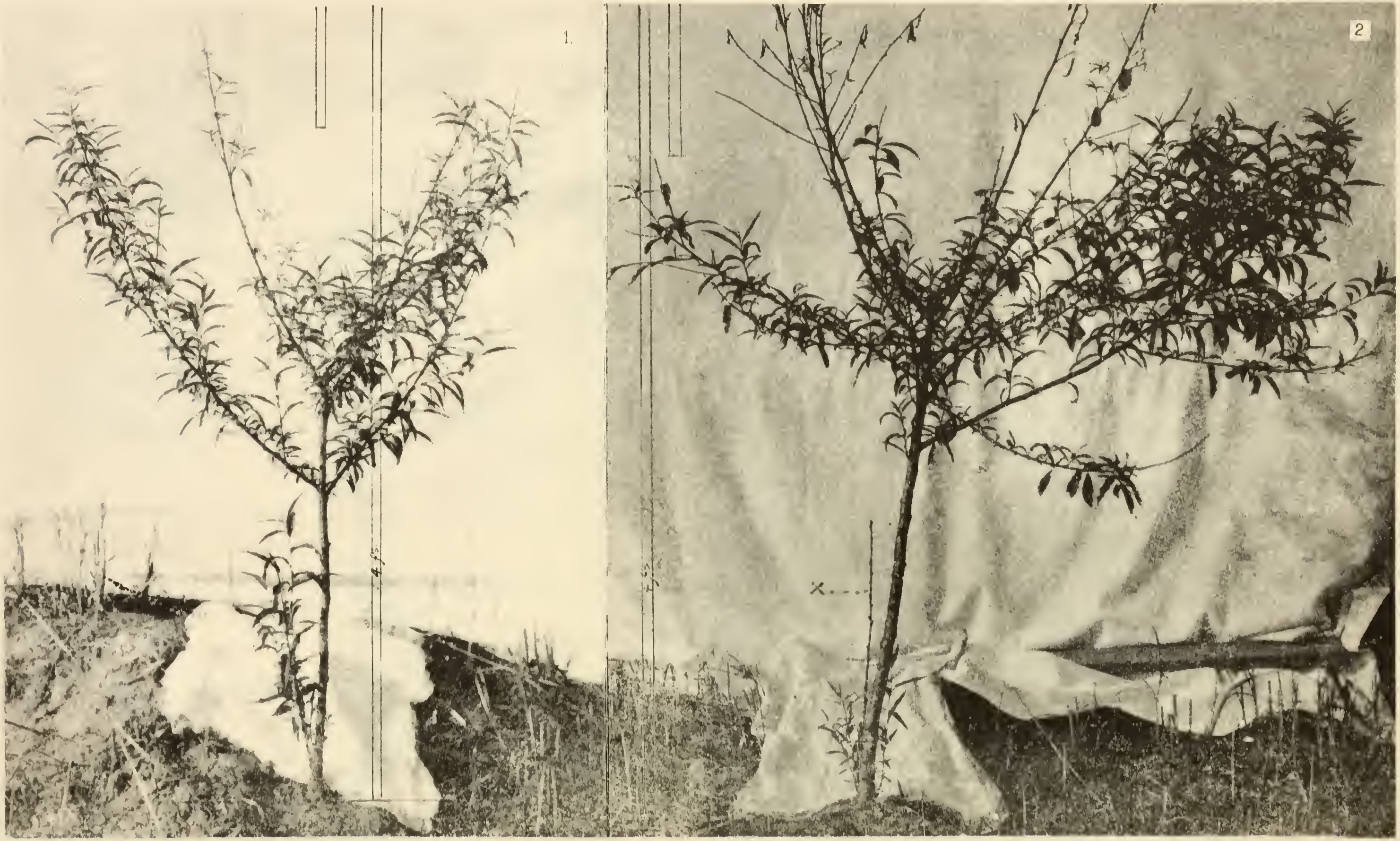
YELLOWS—RESULT OF INOCULATIONS.

Experiment 1, year 1890.



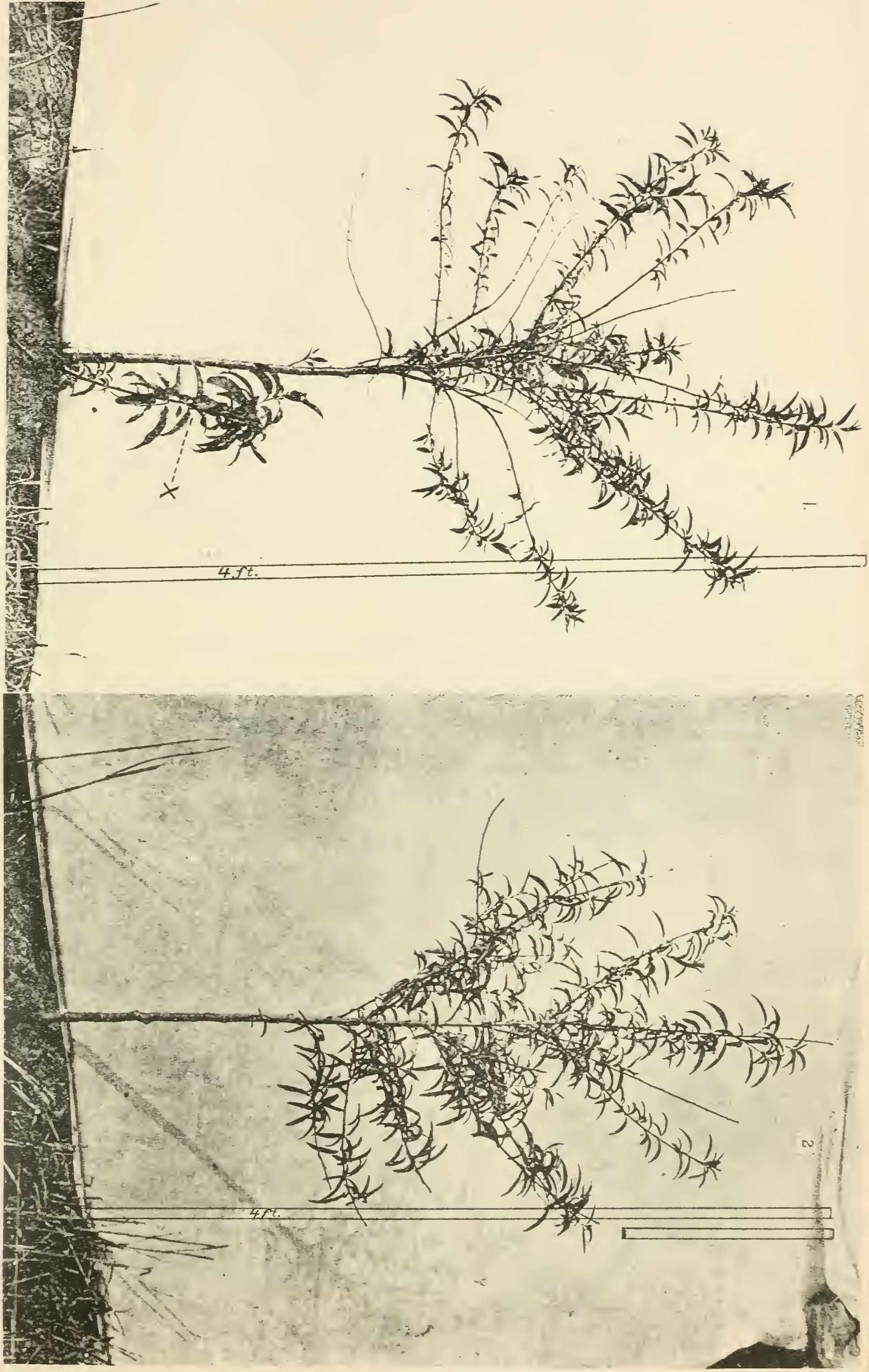
YELLOWS—RESULT OF INOCULATIONS.

Experiment 2, year 1889.



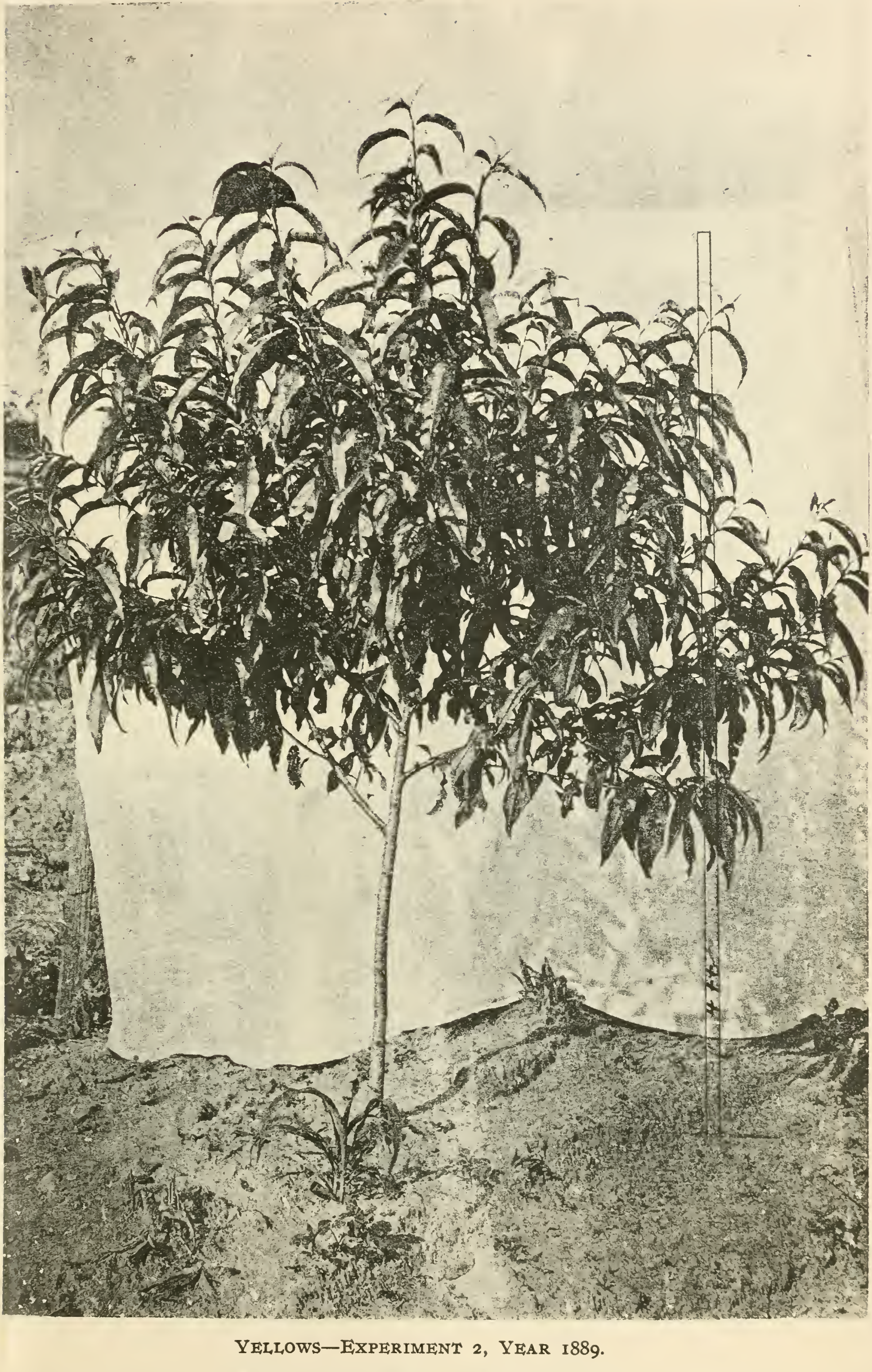
YELLOWS—RESULT OF INOCULATIONS.

Experiment 2, year 1889.



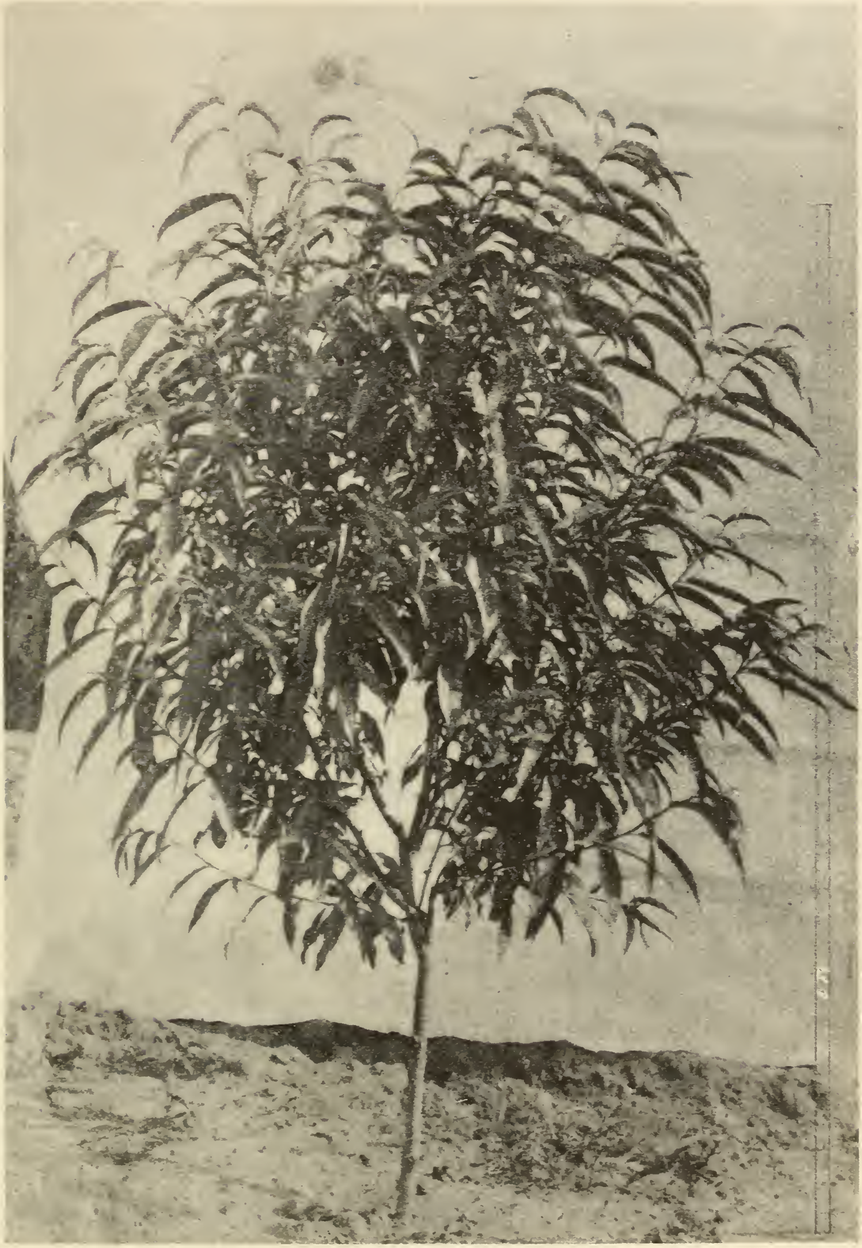
YELLOWS—RESULT OF INOCULATIONS.

Experiment 2, year 1889.



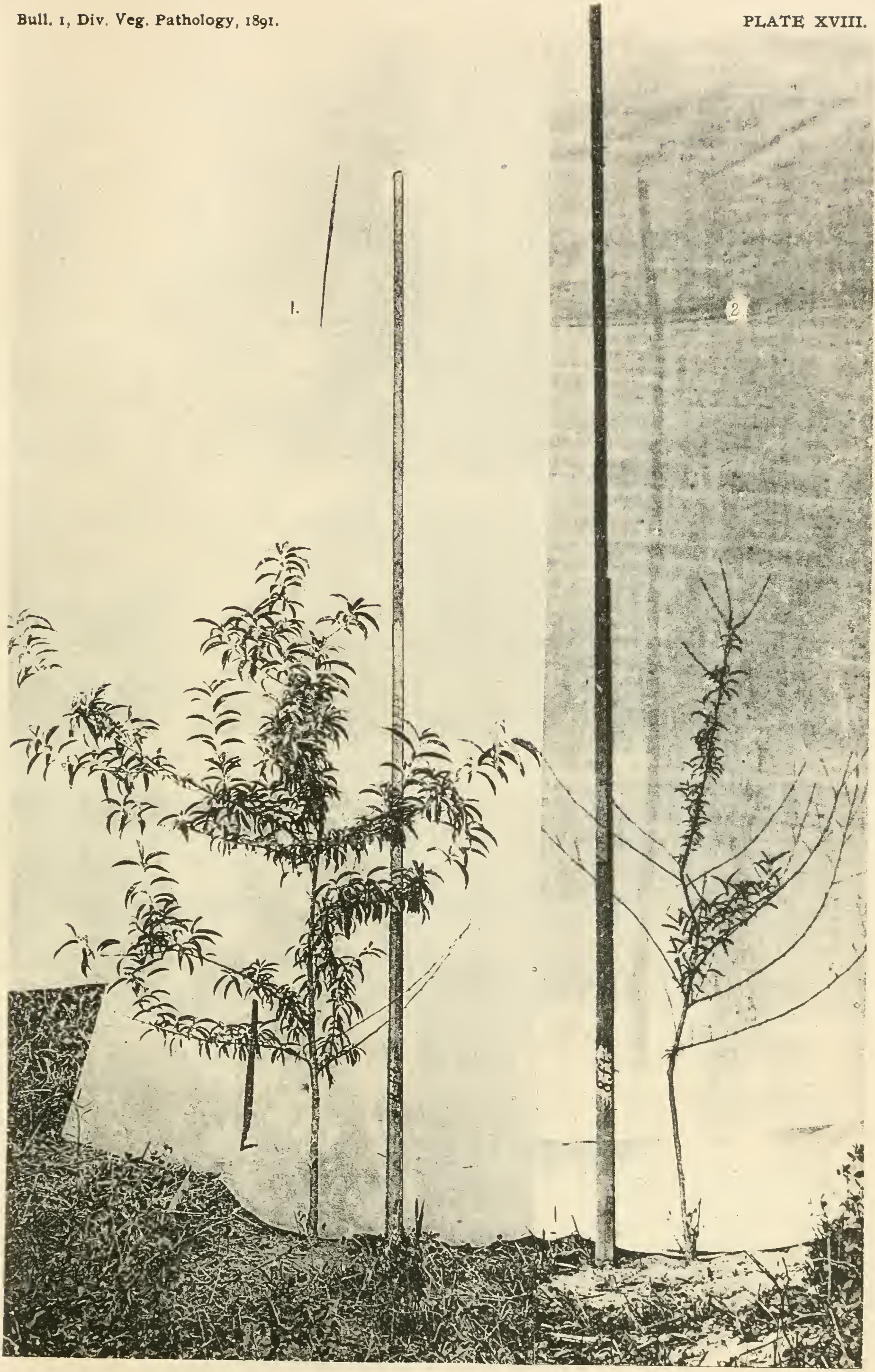
YELLOWS—EXPERIMENT 2, YEAR 1889.

Healthy tree for comparison. See Plates XIII–XV.



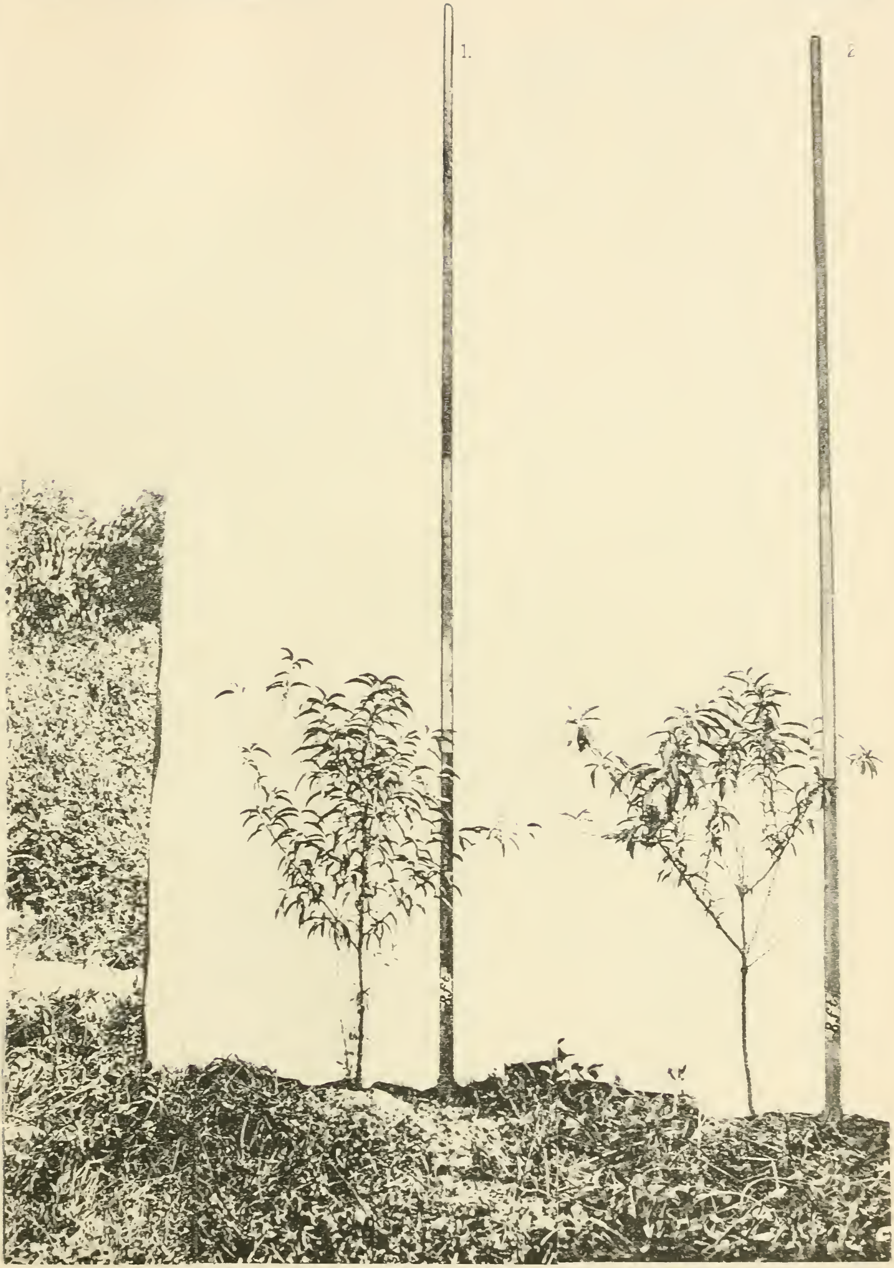
YELLOWS—EXPERIMENT 2, YEAR 1889.

Healthy tree for comparison. See Plates XIII–XV.



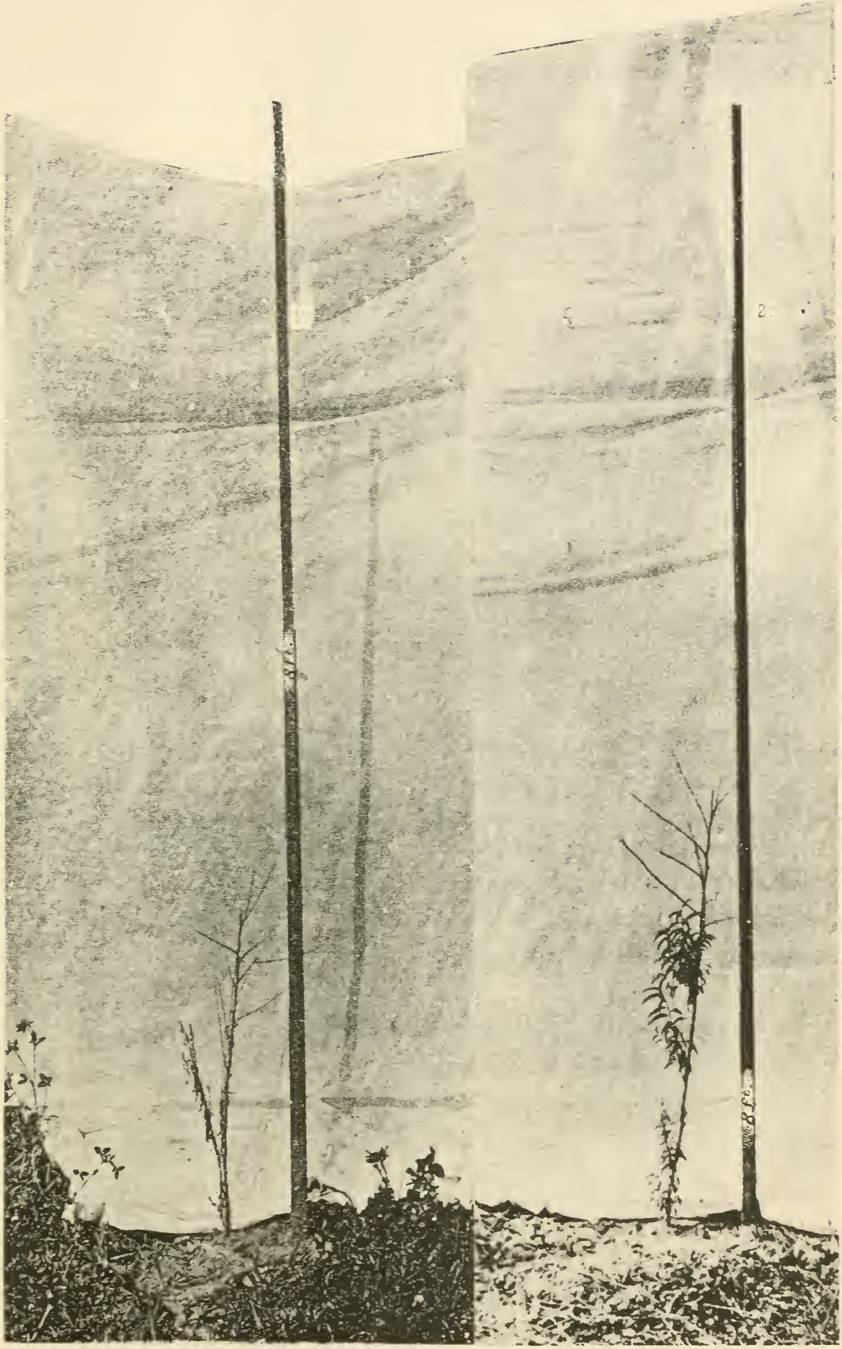
YELLOWS—RESULT OF INOCULATIONS.

Experiment 2, year 1890.



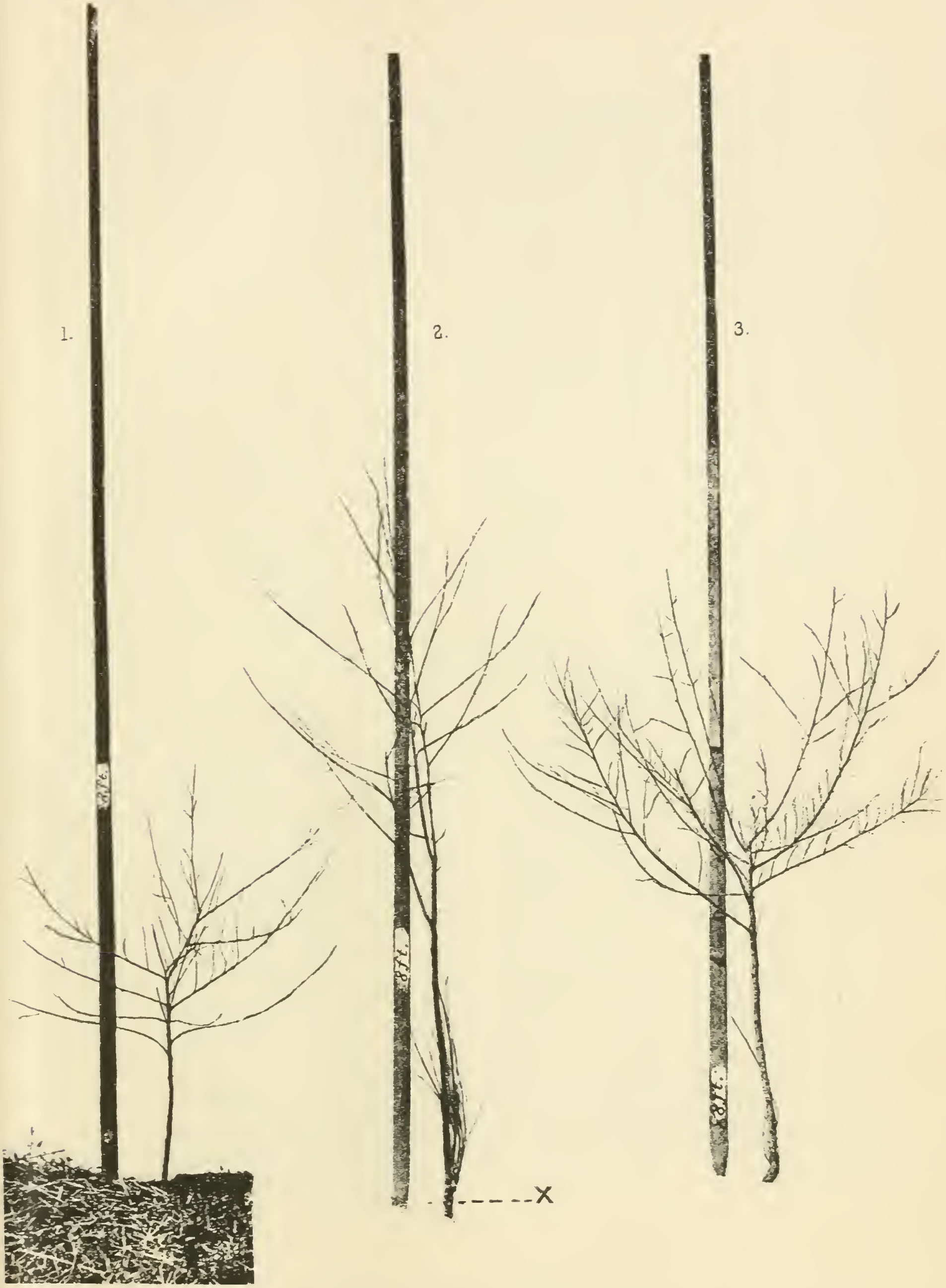
YELLOWS—RESULT OF INOCULATIONS.

Experiment 2, year 1890.



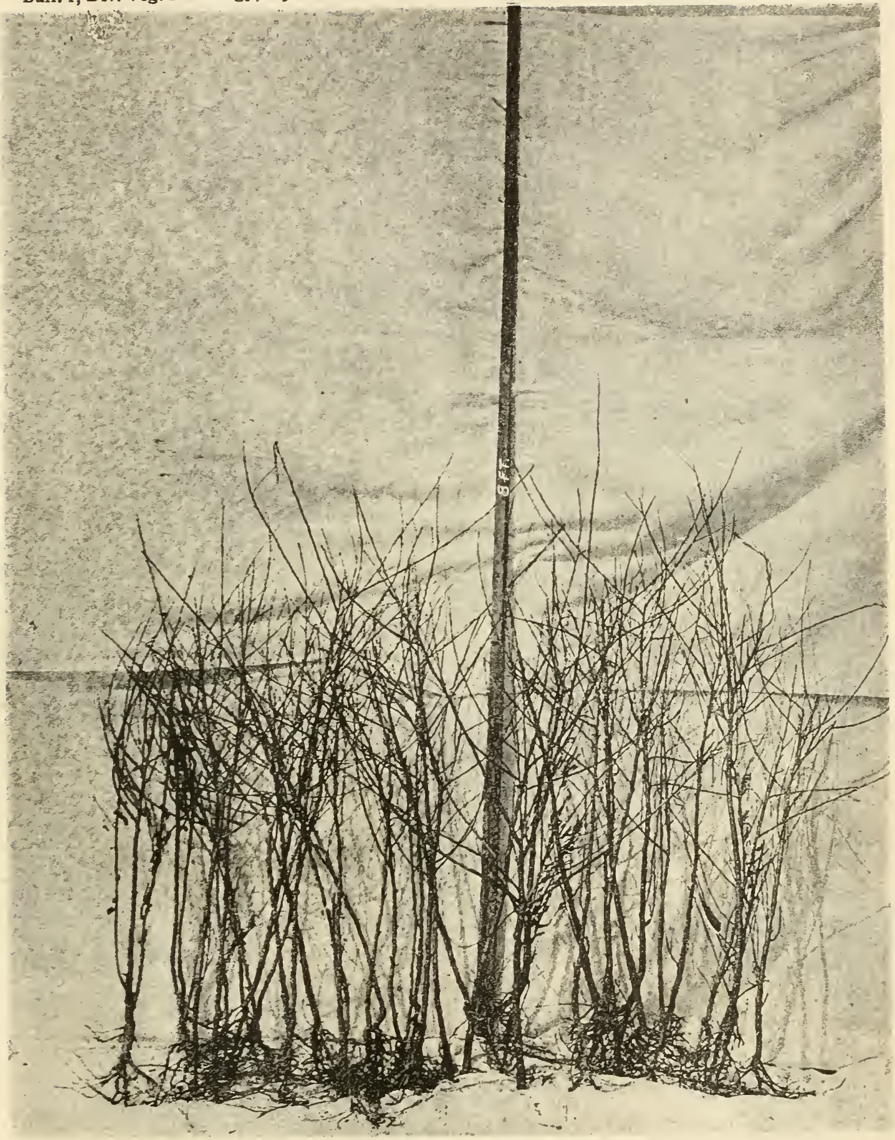
YELLOWS—RESULT OF INOCULATIONS.

Experiment 2, year 1890.



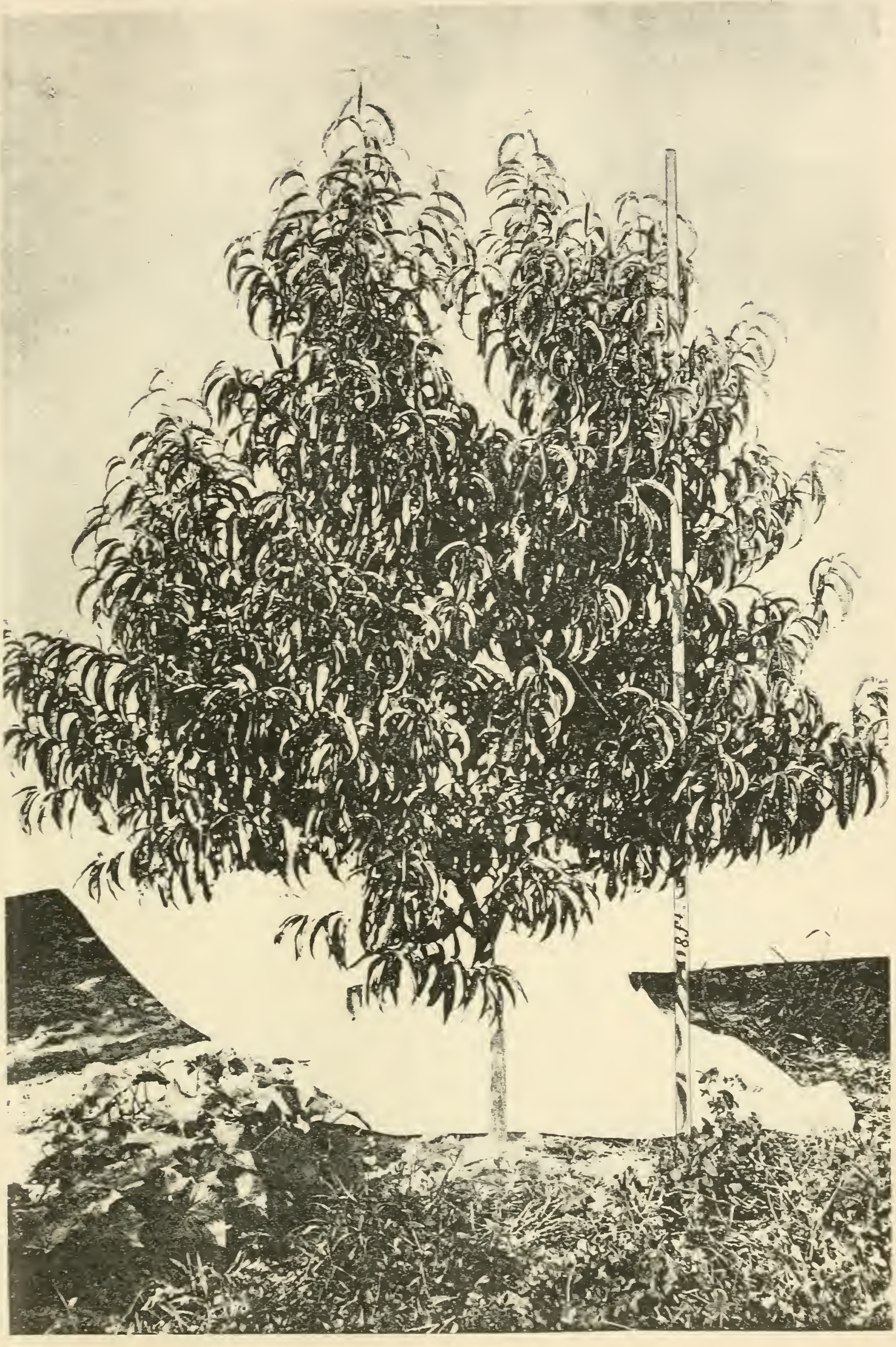
YELLOWS—RESULT OF INOCULATIONS.

Experiment 2, year 1890.



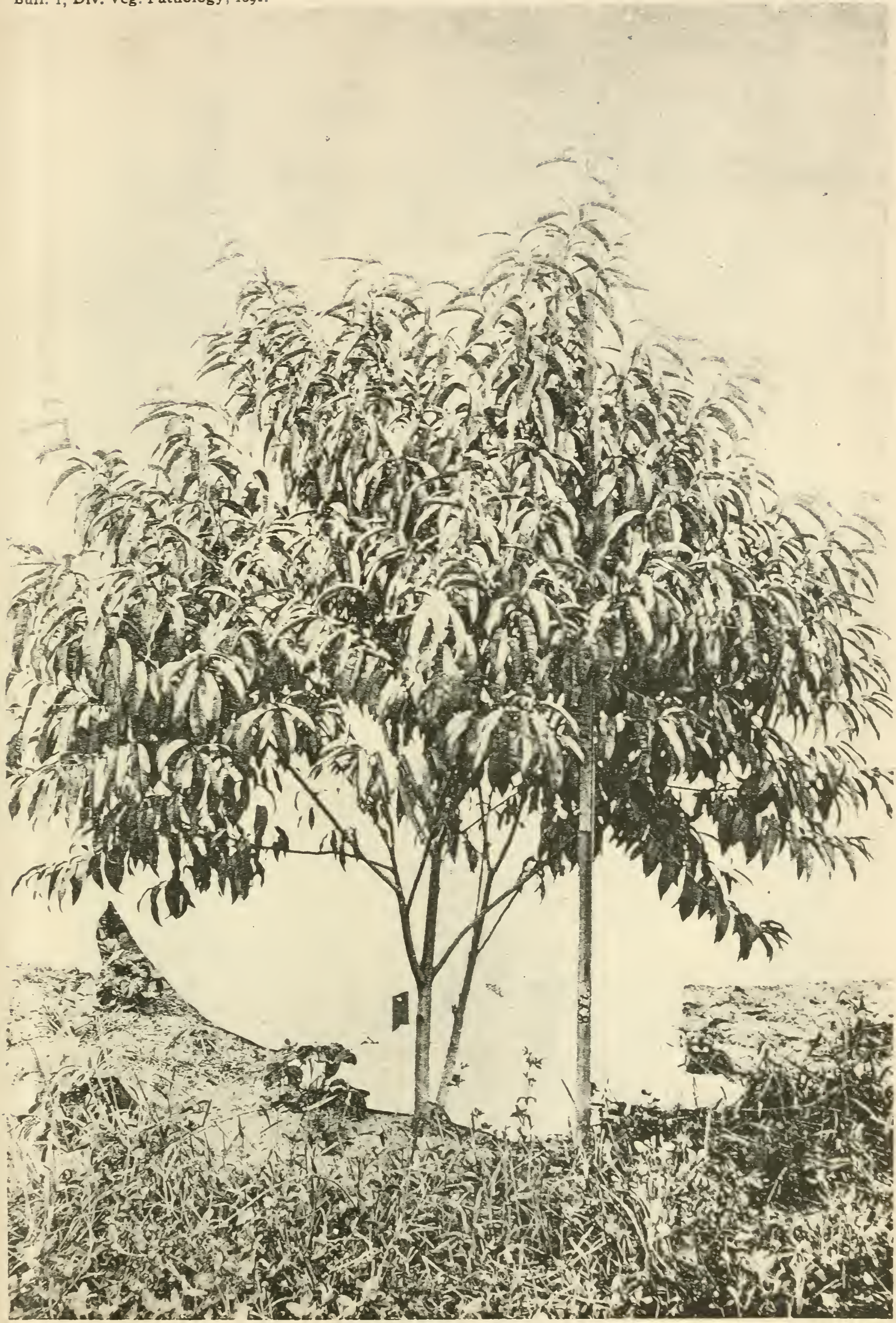
YELLOWS—RESULT OF INOCULATIONS.

Experiment 2, year 1890.



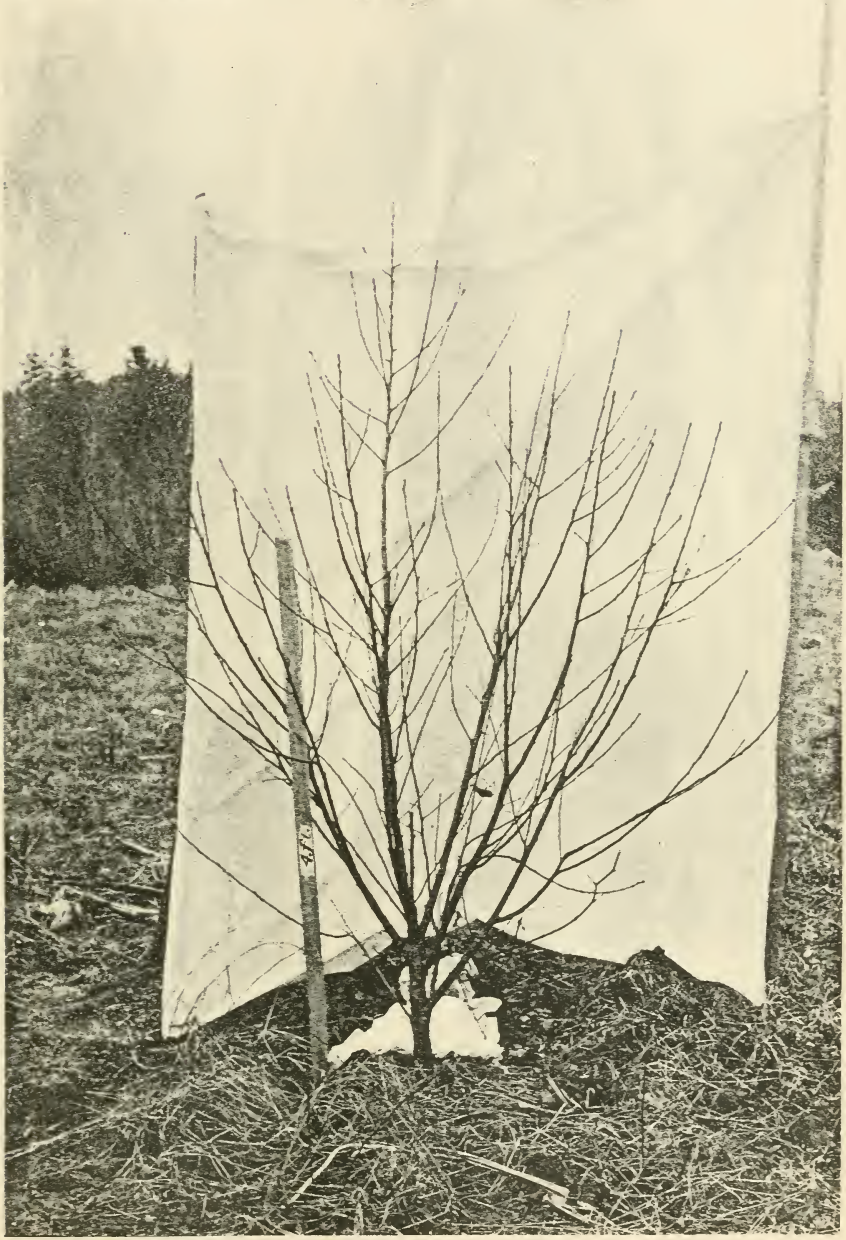
YELLOWS—EXPERIMENT 2, YEAR 1890.

Healthy tree for comparison.



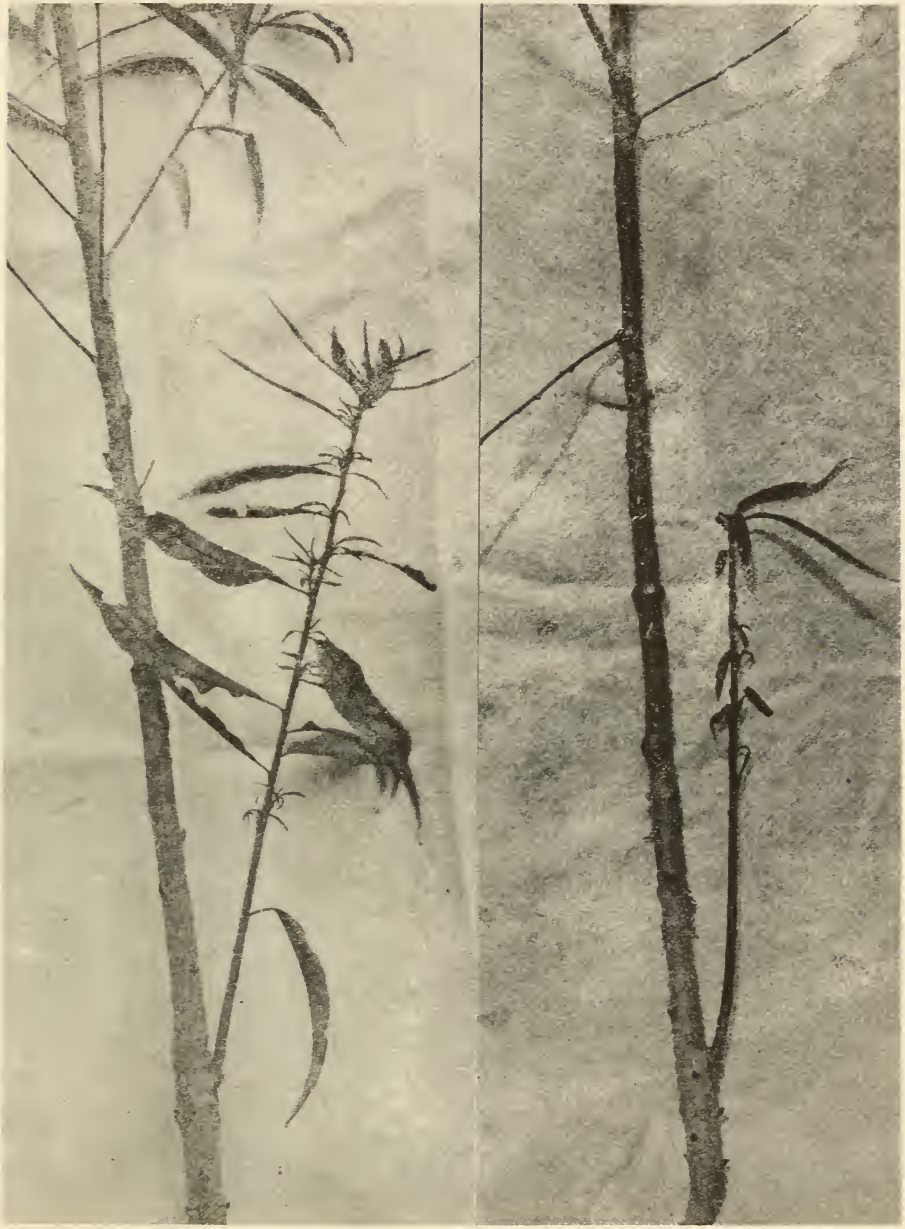
YELLOWS—EXPERIMENT 2, YEAR 1890.

Healthy tree for comparison.



YELLOWS—RESULT OF INOCULATION—TREE STILL HEALTHY.

Experiment 4, year 1891.



YELLOWS—RESULT OF INOCULATIONS.

Experiment 5, year 1890.

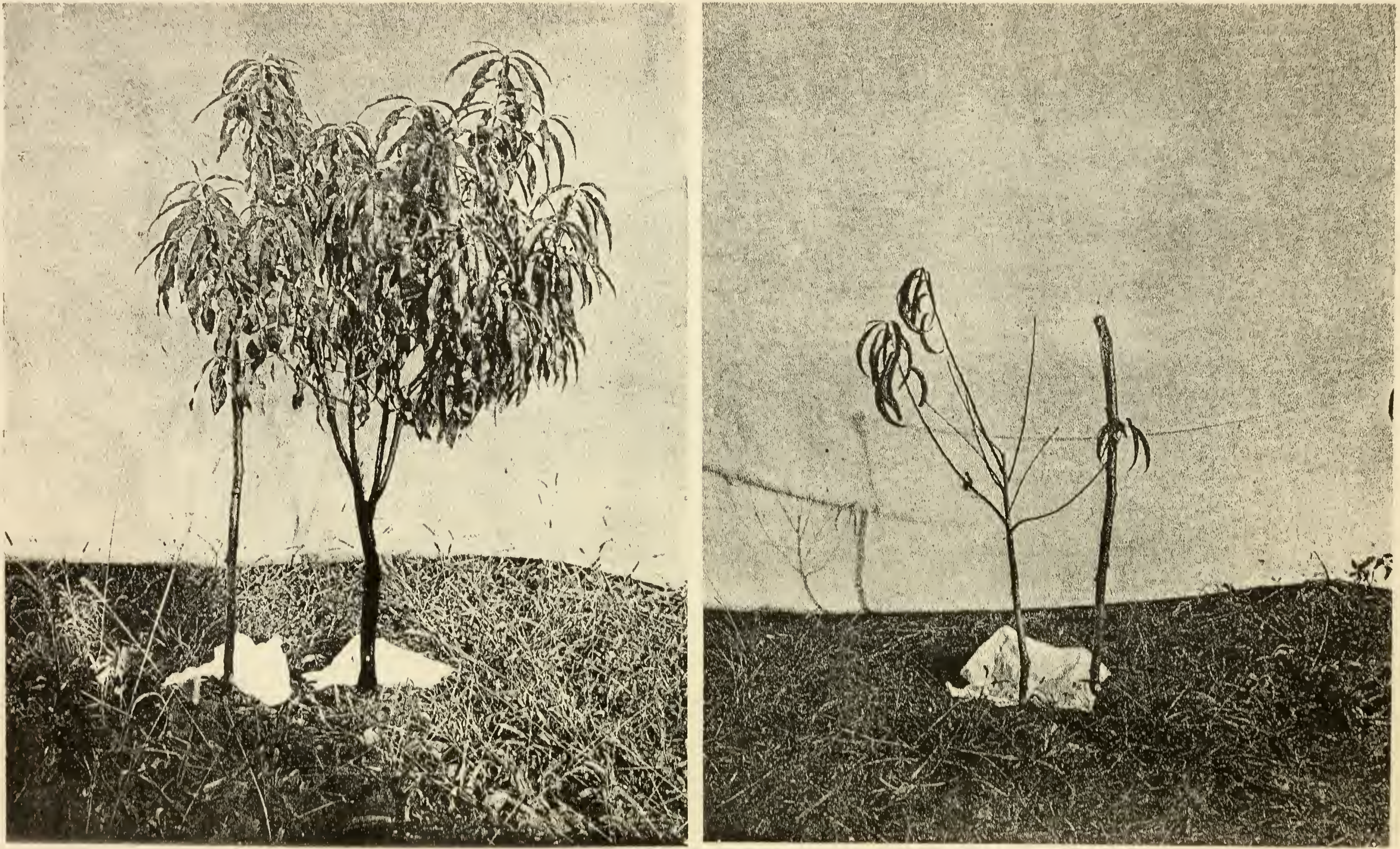
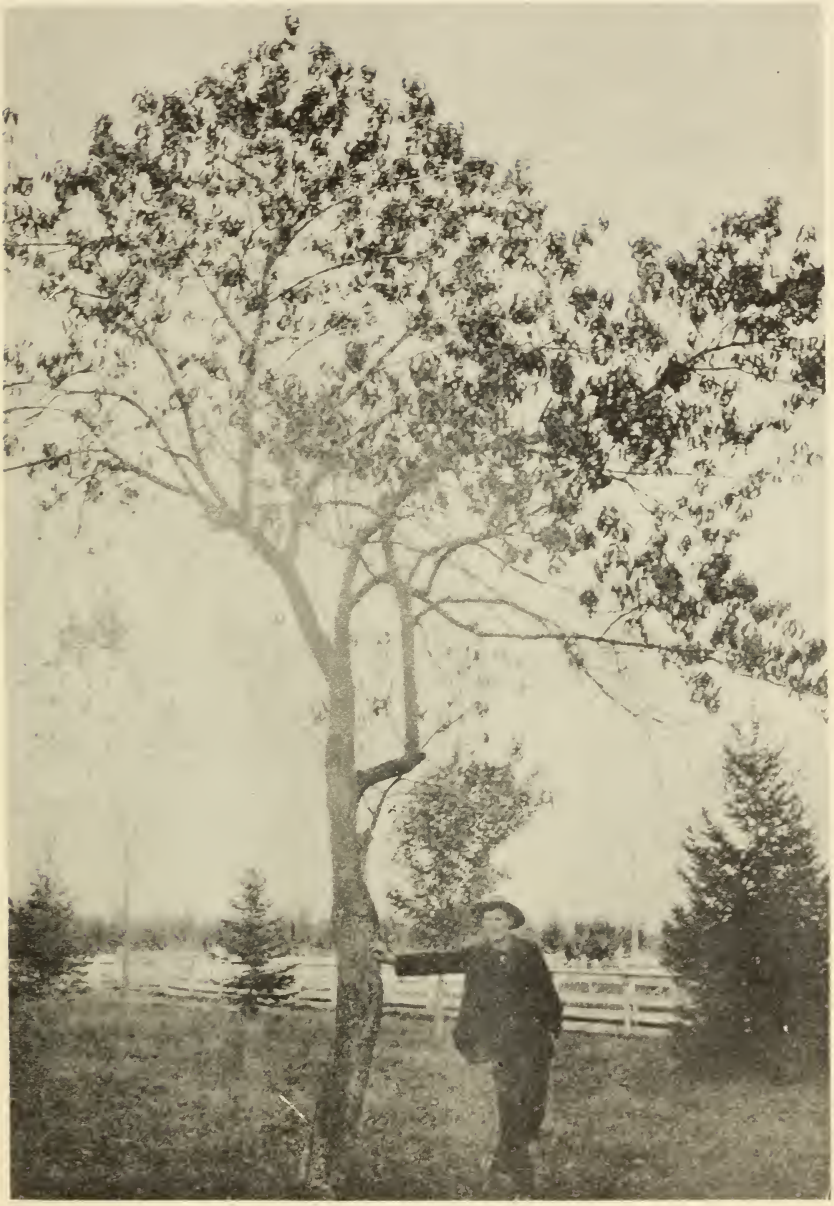


Fig. 1.

Fig. 2.

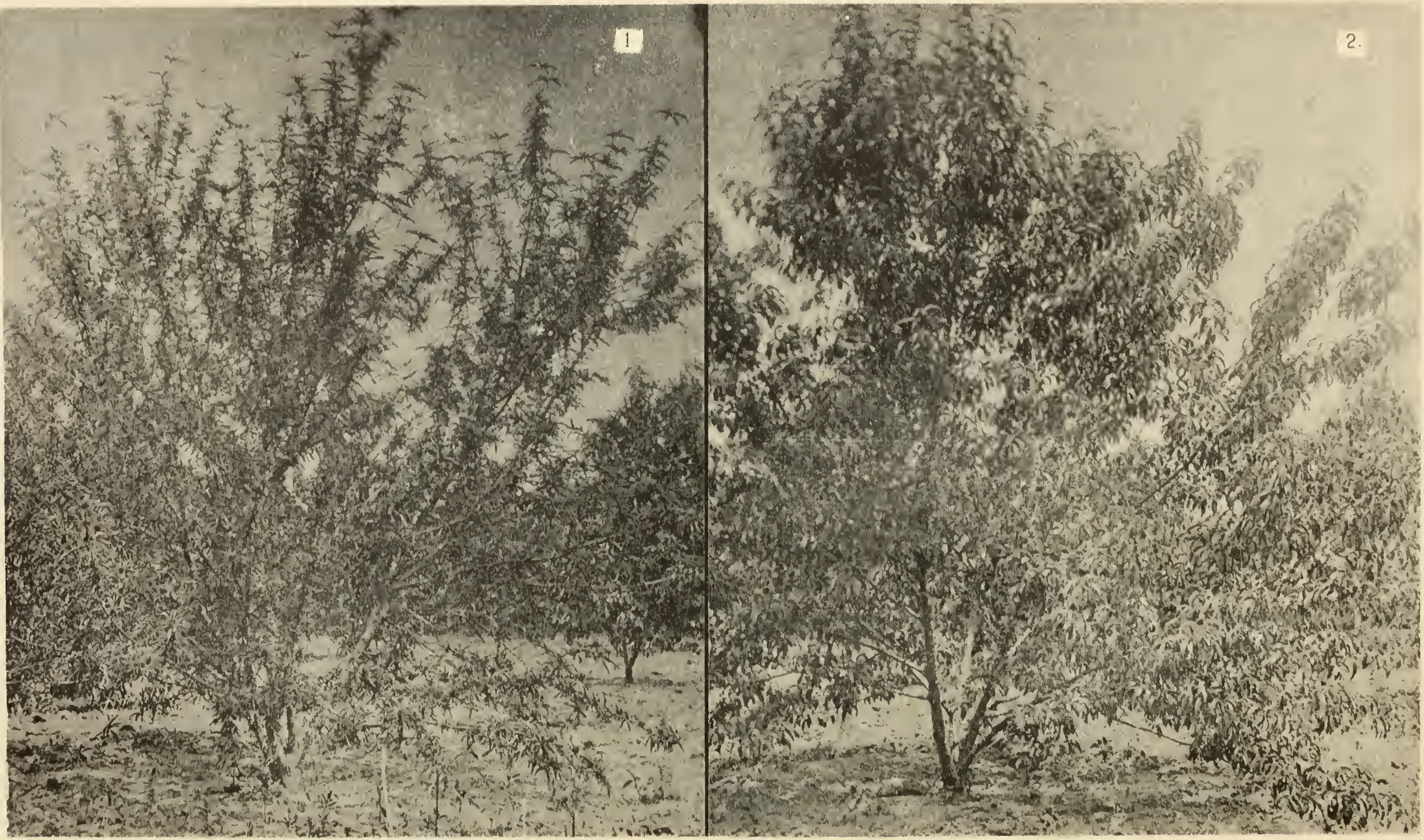
PEACH UPON PLUM.
Experiment 1*c*, year 1890.



PEACH TREE—36 YEARS OLD.

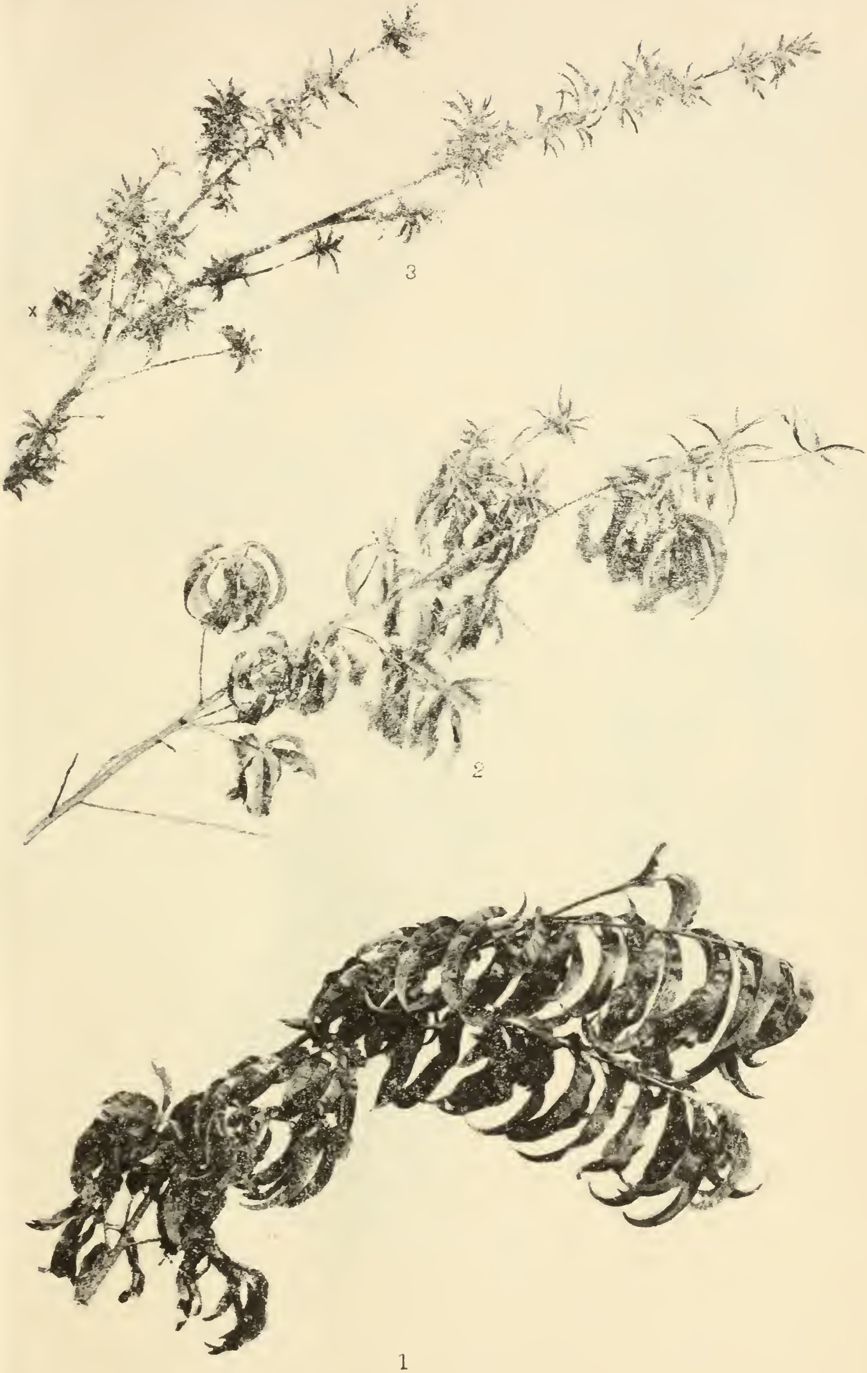
(Free from yellows until 1890.)

Still Pond, Md.



ROSETTE—DISEASED AND HEALTHY TREE—BUDDED FRUIT.

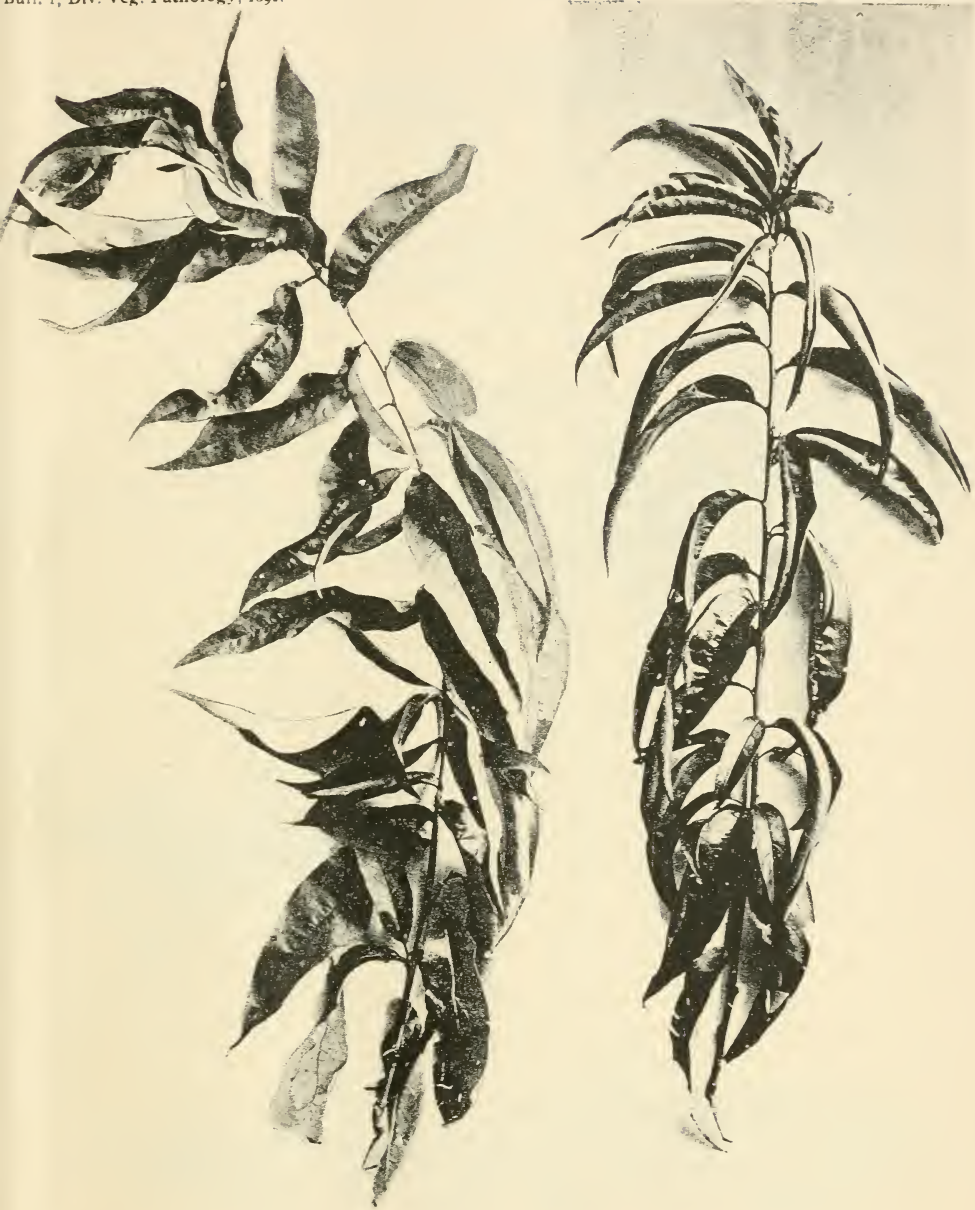
Vineyard, Ga.



ROSETTE—BUDDED TREE.

A healthy branch and two stages of the disease.

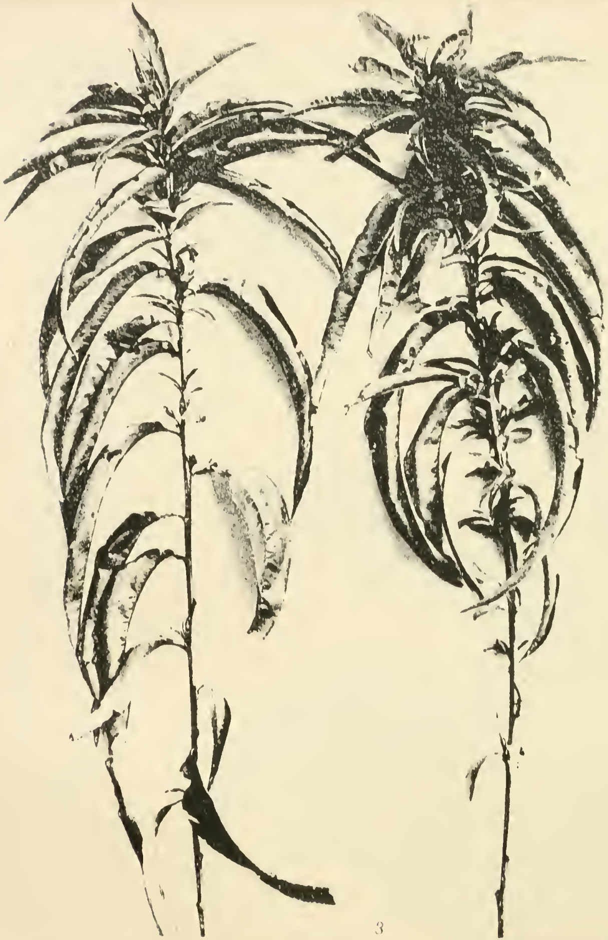
Griffin, Ga.



ROSETTE—SEEDLING TREE.

Fig. 1. Healthy Fig. 2. Slightly diseased.

Sunny Side, Ga.



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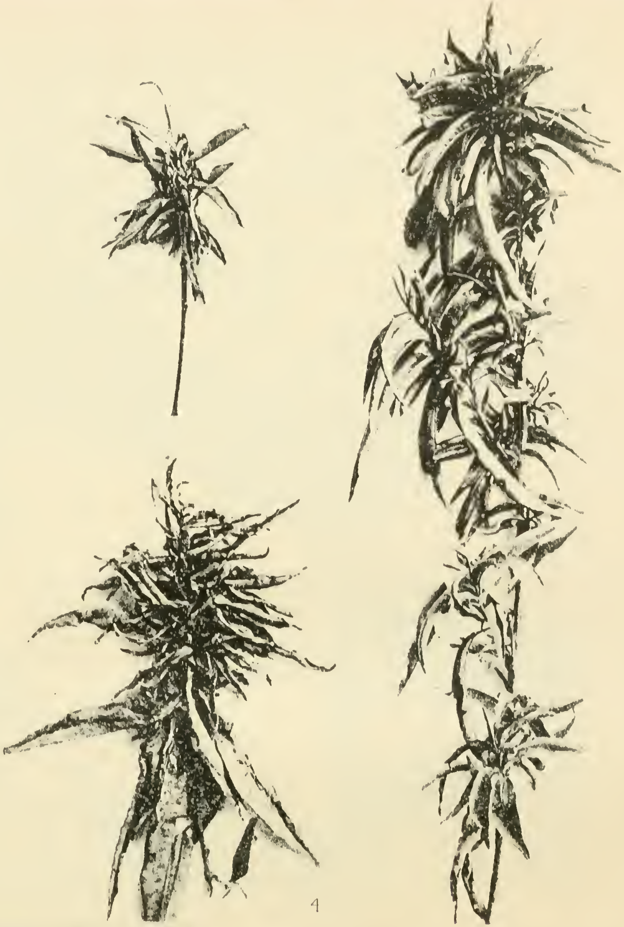

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ROSETTE—SAME TREE AS PLATE XXXI.

Fig. 3. Beginning of tufts. Fig. 4. Fully developed rosettes.

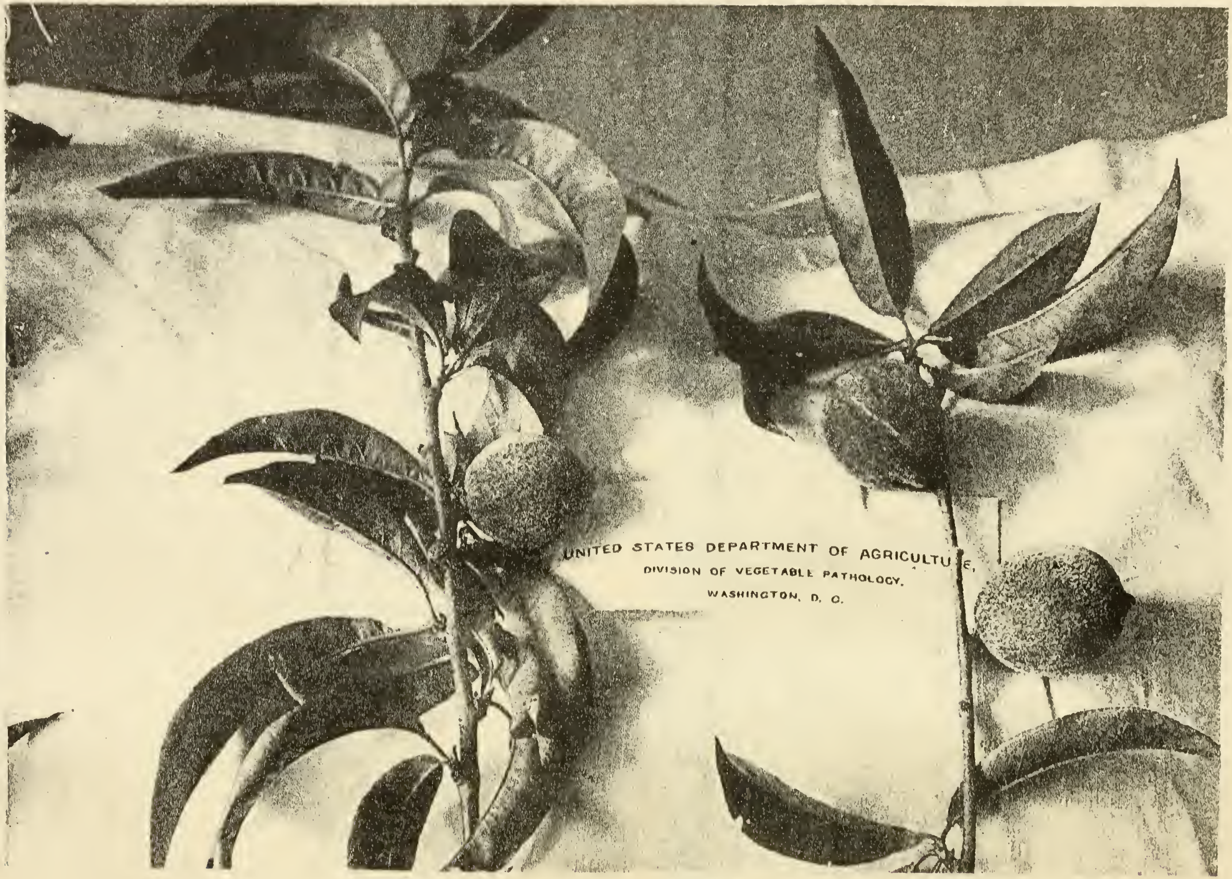

UNITED STATES DEPARTMENT OF AGRICULTURE,
DIVISION OF VEGETABLE PATHOLOGY,
WASHINGTON, D. C.

Fig. 1. Fig. 2.

ROSETTE—GRIFFIN, GA.

1. Diseased branch. 2. Healthy branch.

PLATE XXXIV

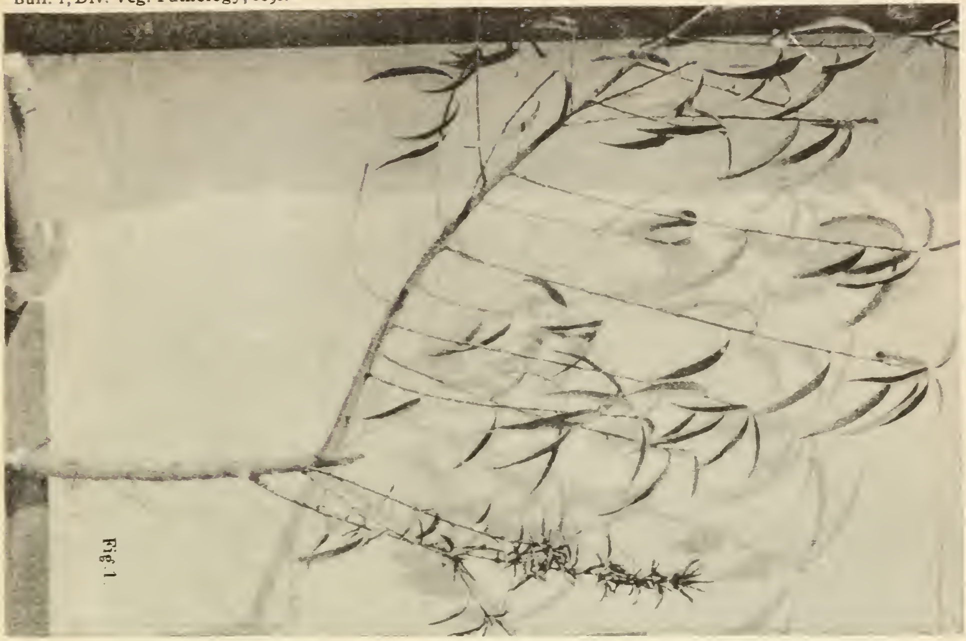


Fig. 1

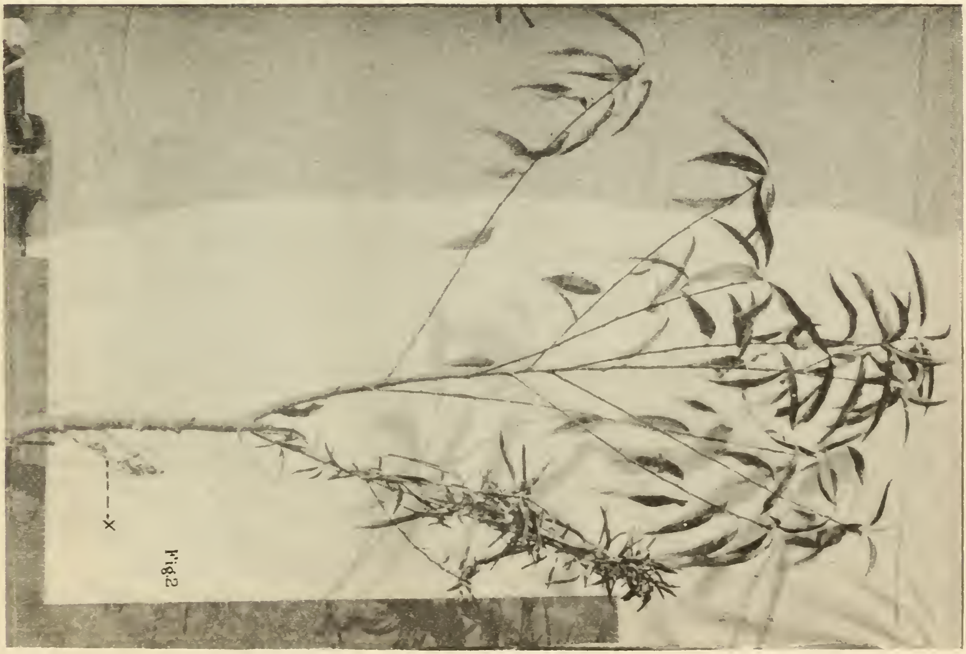
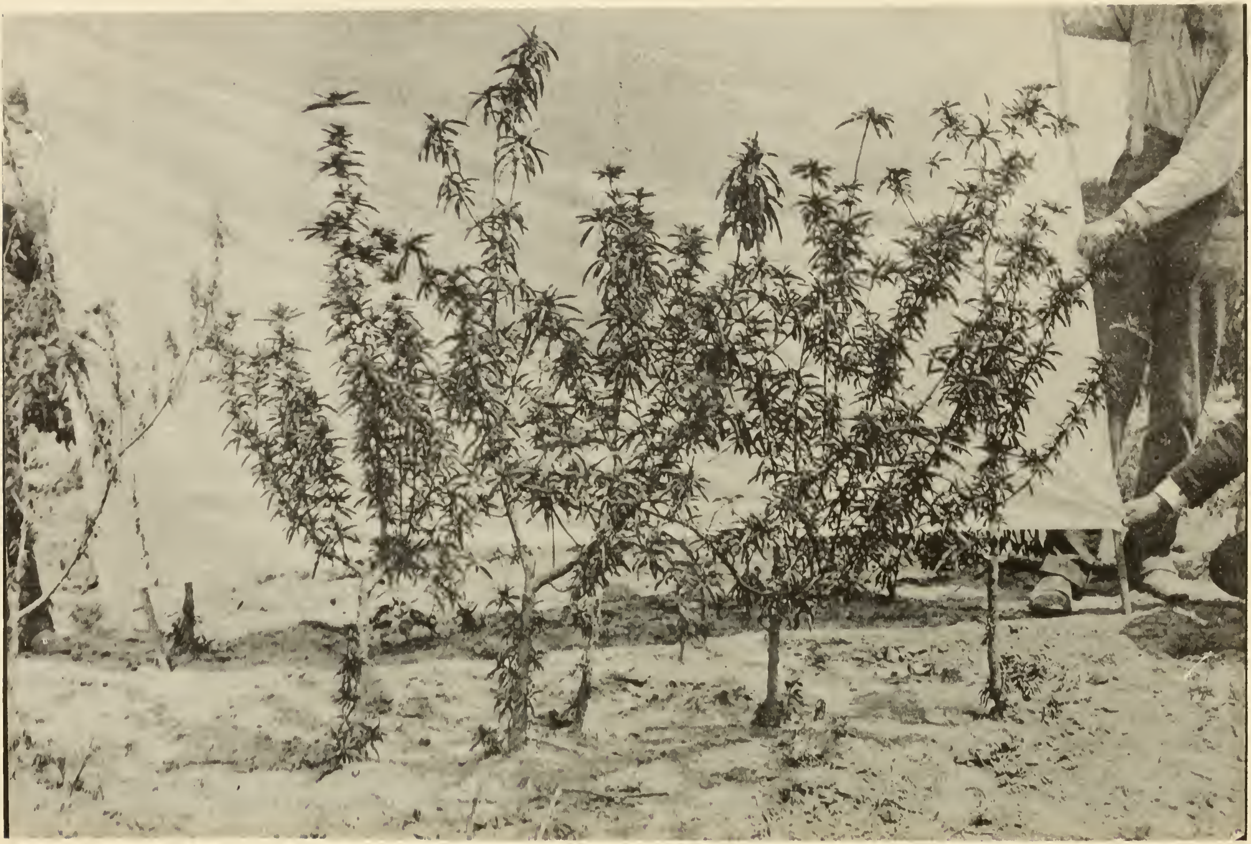


Fig. 2

ROSETTE—RESULT OF INOCULATIONS. (Experiment 1, year 1890.)



ROSETTE—RESULT OF INOCULATIONS.

Experiment 1, year 1891.

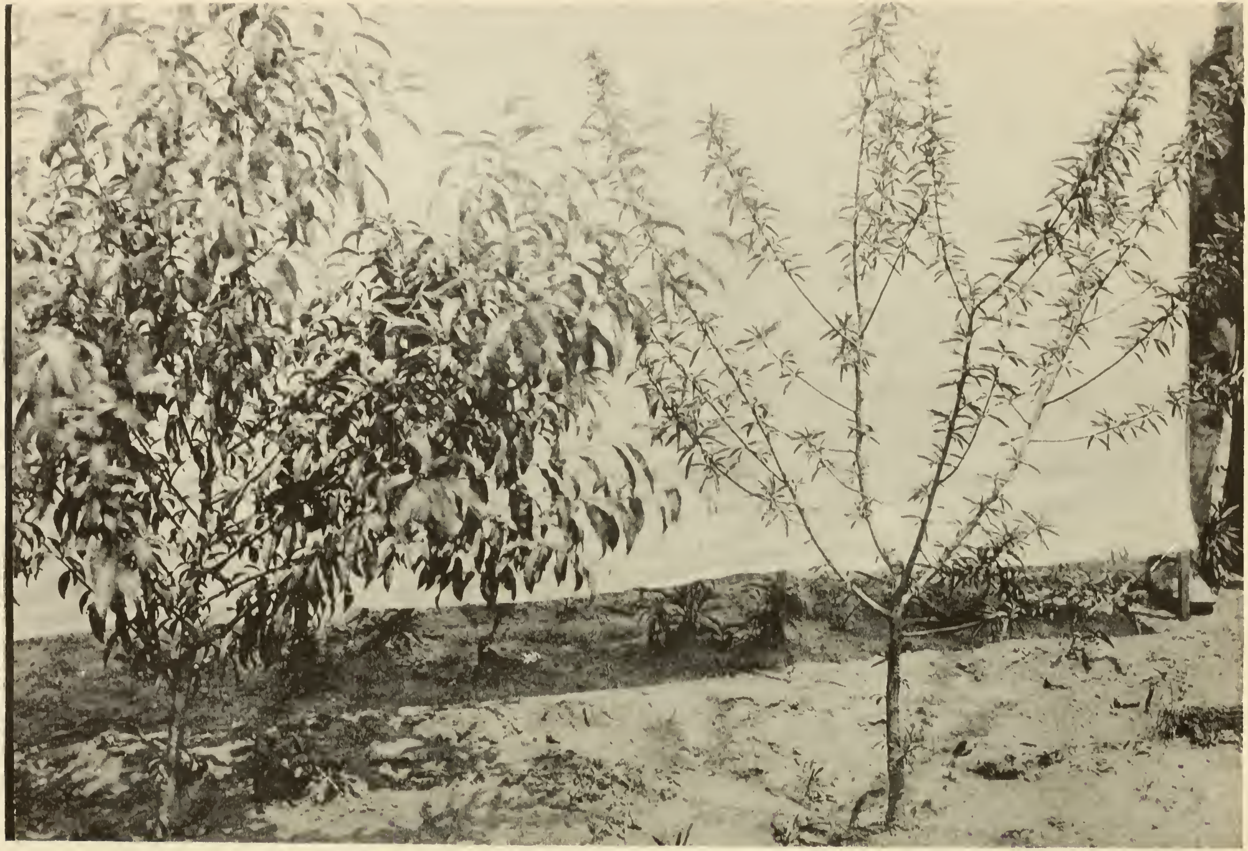
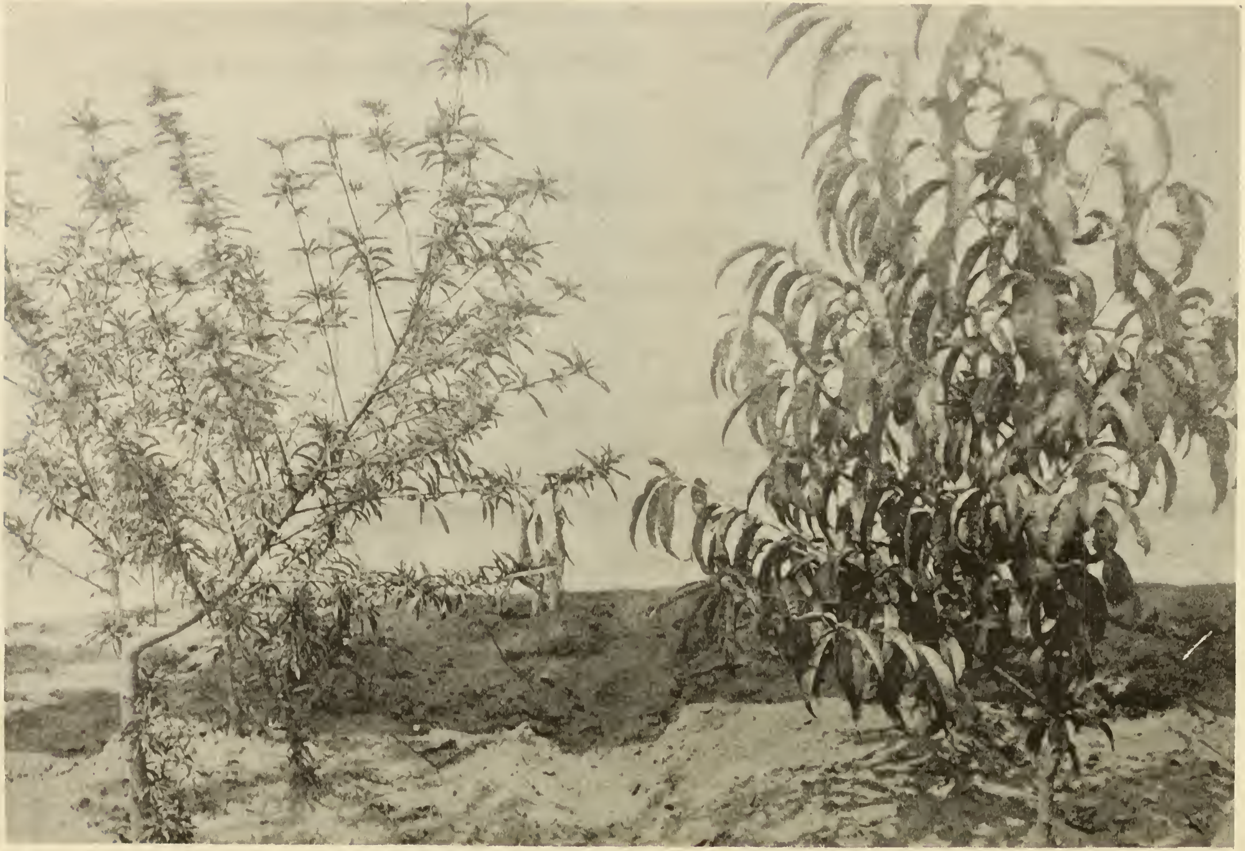


Fig. 1. Fig. 2.

ROSETTE—RESULT OF INOCULATIONS.

1. Healthy seedling. 2, Inoculated Seedling.



ROSETTE—RESULT OF INOCULATIONS.

1. Diseased Trees. 2. Healthy budded.

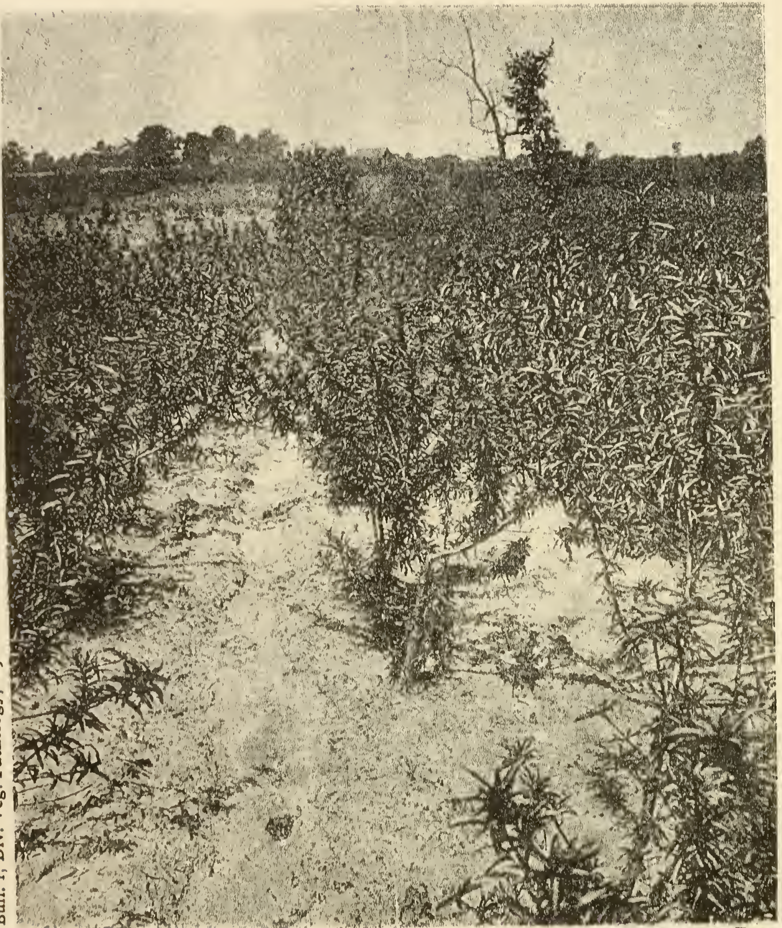


Fig. 1.

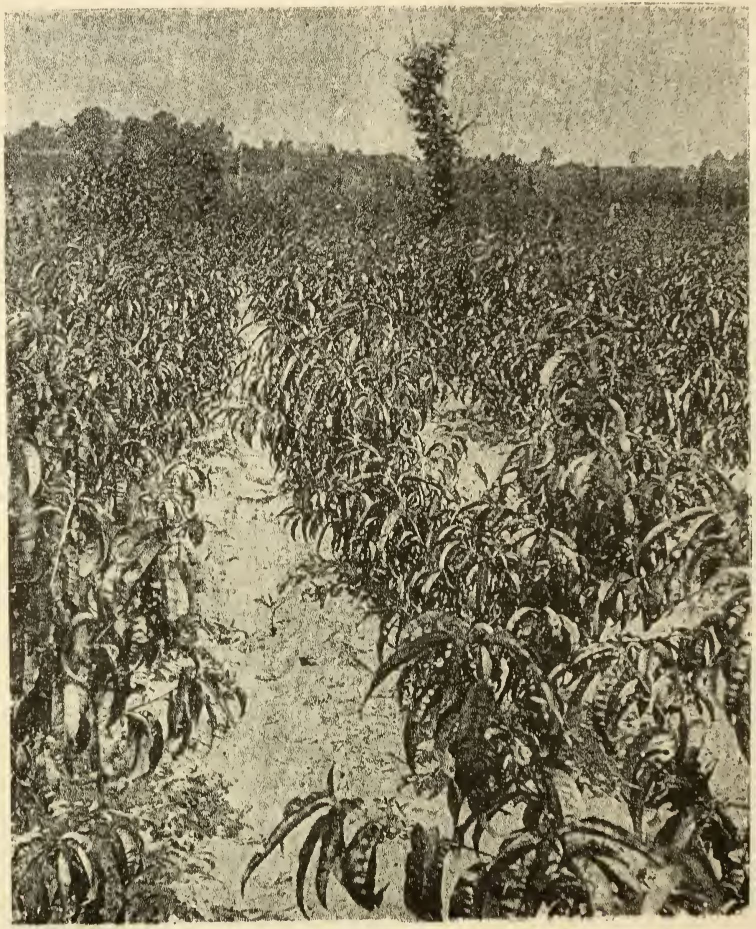


Fig. 2.

ROSETTE—RESULT OF INOCULATIONS.

1. Inoculated rows. 2. Healthy rows adjoining.

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